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Chemical Services Committee

1920

REPORT

00108823

SIMLA
SUPERINTENDENT GOVERNMENT CENTRAL PRESS
1920

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CHEMICAL SERVICES COMMITTEE, 1920

PRESIDENT.

PROFESSOR J. F. THORPE, C.B.E., D.Sc., PH.D., F.I.C., F.R.S.

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DR. K. S. CALDWELL, F.I.C.

MR. R. W. DAVIES, I.C.S.

DR. W. HARRISON.

SIR P. C. RÂY, KT., C.I.E., D.Sc., PH.D., F.A.S.B.

DR. J L. SIMONSEN, F.I.C., F.A.S.B.

DR. J. J. SUDBOROUGH, F.I.C.

SECRETARY.

DR. J. L. SIMONSEN, F.I.C., F.A.S.B.

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Introductory note by the President.

On the 26th of September 1919 I received a letter from the Secretary of State for India in Council asking me to act as President of a Committee about to be appointed by the Government of India "to formulate "proposals for the organisation of a Chemical Service "for India, and for the location and equipment of "research laboratories." I sailed for Bombay on the 17th of October and arrived there on the morning of November 15th.

After remaining for a few days at Delhi, I started on a tour of the Provinces in order to familiarise myself with Indian conditions and during the tour visited Cawnpore, Lucknow, Calcutta, Rangoon, Madras, Coimbatore, Aravankadu, Bangalore, Poona, Bombay, Nasik, Nagpur, Jamshedpur, Pusa, Lahore, Jallo, Amritsar, Dehra Dun and Simla, reaching the last named place on the 2nd of February 1920.

During the tour it soon became apparent that the development of the Chemical Industries of India could only be adequately realised through the agency of an efficient Government Chemical Service. Very few of the great natural resources of the country were being exploited to advantage and where, here and there, this was being done the processes employed were often crude and wasteful. It was evident that if the resources of the country were developed to their fullest extent, India would take her place in the front rank of industrial communities and would benefit by all the advantages that this implies.

In the Provinces visited, there was no lack of appreciation of this fact, but the main trouble seemed to be the absence of any effective organisation to advise and co-ordinate the various efforts which were being made to meet the situation. Moreover, although the need was clear to them, none of the Provinces had as yet formulated a programme of their requirements nor had they decided what educational methods were necessary to achieve the desired ends.

They did not know, for example, whether the problem could be solved by the erection of technological institutes, schools of technology or research institutes and no very clear ideas were held as to the meaning of these terms. But it was generally agreed that either the one or the other was necessary.

I explained that in a country such as India there was an unquestionable need for technological institutes, but that these should be more properly called Trades Schools because in them men of the foremen type should receive instruction in the technique of their trades. The difference between a pure and an applied chemist is relative only and a chemist, whether he ultimately intends to devote his life to academic or to industrial pursuits, must, in the first instance, receive a thorough training in his subject by passing through a recognised course such as that given in an Honours' School at a British University.

Even then the dividing line between pure and applied chemistry has not been reached, but one or two years' subsequent training in the methods of research, coupled with instruction in the principles of engineering and machine drawing, where such training has not been already formed a part of the Honours' course, is necessary both for the industrial and academic chemist.

After such training, the chemist should be in a position to turn his hand to anything chemical. If he decided to enter industry, he might do so at once because his mind would be in a condition rapidly to assimilate the technical details of the chemical processes underlying the work of the factory into which he entered. It is interesting to note that one of the leading chemical manufacturers in America, and more than one in England, have told me that chemists trained in this way were all they required. If, on the other hand, instead of following industrial pursuits, the chemist decided to enter academic life, he would be, after such training, in a position to teach and instruct others in the methods of chemical research.

In my opinion it is the duty of the Universities and of University Institutions not only to instruct men intended for a chemical career in the theory and practice of chemistry, but also to imbue them with the enthusiasm and initiative which only a training in chemical research can impart. In other words, the Professors of Chemistry in Universities and University Institutions should be researchers in chemistry as well as teachers and, in fact, it is the first duty of a University to advance knowledge, its second duty to impart it.

Steps are being taken in the right direction notably at Calcutta and in Madras. Bombay I found to be strangely behindhand in its training of chemists, but no doubt this state of affairs will be improved when the status of the College of Science has been settled. University education in chemistry in the other Provinces appears to be still largely in the making, although most of them are fully alive to the need for an effective training both in the Science and in Research.

Personally, I am not convinced that true chemical

"technological" training can be imparted without actual works experience, such experience being gained by a man who has passed through a course on the lines I have suggested. Engineers gain their practical training by passing through the shops, physicians and surgeons by passing through hospitals, but the chemist is usually considered effectively trained after he has obtained an Honours' Degree in his University.

In my opinion he is, at this stage, no more proficient than a medical man would be without hospital experience, or an engineer without knowledge of workshop practice. Many attempts have been made to meet this deficiency and in at least one Indian University the suggestion was made to me that post-graduate students should be drafted to some chemical works in order to gain factory experience. This, however, is an old suggestion which has been tried in England, notably by the Board of the 1851 Exhibitioners who have instituted Industrial Bursaries by which, I believe, a post-graduate student is enabled to make arrangements with any works he thinks fit for training him in factory methods. I do not know how this scheme has worked generally, because only one student of mine held a Bursary of this kind and in his case, although he attended a prominent factory for a year, he was allowed to learn nothing of the processes carried out there and spent his time in routine work in the research laboratory. Such a result seems to me inevitable, when we remember that chemical manufacturers are usually loth to give the run of their works to casual students who are not in any way bound to them. In fact the only chemical factory which appears to be open to students is the Municipal gas works and here in India works of this kind are not numerous. There is, however, no doubt that much can be done by improving the general course of training in

chemistry afforded by an Honours' school. For example, at the present time a course of instruction in organic preparations is carried out entirely by means of glass apparatus. There is no reason why students during their course should not also be instructed in the use of large scale appliances, which would supply conditions involving the use of metal apparatus and the connections incidental thereto.

It is, of course, impossible and unnecessary to have laboratories attached to Universities fitted with full scale apparatus, but it is quite possible to erect a laboratory, of comparatively small dimensions, containing types of every kind of plant used in chemical manufacture, of about 1-60th the size of the large scale plant. A laboratory of this kind should, I think, be attached to the chemical department in every University.

So far as the Chemical Service proposed in this Report is concerned, it is intended that such factory experience, as may be required, will be given in one or other of the pioneer or demonstration factories which it is proposed to erect, but it is not suggested that this should obviate the need for University training such as that outlined above.

In the text of the Report the Committee has given its reasons for recommending the establishment of Provincial Research Institutes, at the chief centre of industry in each Province, under the control of the Provincial Governments, and the provision of a Central Research Institute under Imperial control at Dehra Dun. The relationship of the Imperial Institute to the Provincial Institutes is given in detail, but I may add here that there is no intention to confer on the Imperial Institute the power to exercise any administrative control whatever

over a Provincial Institute. The links which bind the two are those of good-will and common interest. It is hoped that for the common good these links will remain unsevered.

I wish to express my thanks for the help and generous hospitality extended to me throughout my tour by the Local Governments of the Provinces I visited.

JOCELYN THORPE.

Simla, 28th February 1920.

CHAPTER I.

Introduction.

1. The terms of reference to our Committee were :—

(1) To consider whether an all-India Chemical Service is the best and most suitable method of overcoming the difficulties and deficiencies pointed out by the Indian Industrial Commission.

(2) In the event of the Committee approving the principle of an all-India Service, to devise terms of recruitment, employment and organisation ; to indicate the extent to which chemists already in Government employ should be included in that service ; and to suggest what should be the relations of the proposed organisation with the public and with Departments of the Government of India and of Local Governments.

(3) In particular to frame proposals for the location, scope and organisation of institutions for chemical research.

The Committee was constituted as follows :—

President :

1. Professor J. F. Thorpe, C.B.E., D.Sc., Ph.D., F.I.C., F.R.S., Professor of Organic Chemistry in the Imperial College of Science and Technology, London.

Members :

2. Dr. K. S. CALDWELL, Ph.D., F.I.C., Principal, Patna College.

3. Mr. R. W. DAVIES, I.C.S., District and Sessions Judge, North Arcot, Madras Presidency.

4. Dr. W. HARRISON, Imperial Agricultural Chemist, Research Institute, Pusa.

5. Sir P. C. RAY, Kt., C.I.E., D.Sc., Ph.D., F.A.S.B., Palit Professor of Chemistry, University College of Science, Calcutta.

6. Dr. J. J. SUDBOROUGH, Ph.D., F.I.C., Professor of Organic Chemistry, Indian Institute of Science, Bangalore.

7. Dr. J. L. SIMONSEN, F.I.C., F.A.S.B., Forest Chemist, Forest Research Institute and College, Dehra Dun (Secretary).

2. The Committee met at Simla on Monday February 16th and sat until Saturday February 28th. Previous to this the President, accompanied by Mr. Davies and Dr. Simonsen, toured through the Provinces, visiting the places mentioned in the President's introductory note. Tour notes were prepared and these, together with the conclusions arrived at by the President and those members of the Committee who accompanied him, were placed before the Committee at the first meeting.

3. It has been thought desirable to confine the Report, as far as possible to the subject matter of the remit. On this account all reference to the history of the subject and to existing conditions has been omitted, because these matters have already been fully dealt with in the Report of the Indian Industrial Commission. For the same reason we have made only a brief reference to the

question of pioneer and demonstration factories, for, important as this subject undoubtedly is for the effective development of industry, we do not consider that we could have improved on the description of the position given in the above Report.

4. If the Chemical Service proposed in this Report is to achieve success, it must be recruited mainly from Indian sources. The question therefore of adequate chemical training in Indian Universities is vital. The President has thought it desirable to deal with this subject in a separate introductory note in which his own views on this important question are expressed. It may be added, however, that the Committee agree with the views expressed therein.

5. The Report contains proposals for pay, pension and allowances, and for leave and study leave regulations. It is possible that these may appear to be more generous than those hitherto in vogue, but it must be remembered that, if the Chemical Service is to achieve the objects for which it is proposed that it should be established, it must be staffed with men of the best type the Universities can produce. Both in India, as in England, it is evident that men with the best brains find little inducement to adopt a chemical career. The higher posts are poorly paid in comparison with the emoluments which are received by a successful lawyer or prominent medical man, while the pay of the rank and file is not unusually on a par with that of the navvy and below that which can easily be obtai- encouragement the collier or mechanic.

CHAPTER II.

General.

Necessity for a Chemical Service.

6. The Committee have had before them a large body of written evidence, furnished both by officers of Government and by non-officials and forwarded to them by the Imperial and Provincial Governments. A large proportion of the written evidence is so definitely in favour of the formation of a Chemical Service that the Committee has assumed for the purpose of their report that question No. 1 of their remit namely "To consider whether an all-India Chemical Service is the best and most suitable method of overcoming the difficulties and deficiencies pointed out by the Indian Industrial Commission" could be answered in the affirmative by the formation of a service having as its primary objective the encouragement of industrial research and development.

Co-operation of Science and Industry.

7. In reaching this conclusion the Committee had in mind the measures which have been and are being taken elsewhere to give effect to the great results which were achieved during the late war by the close co-operation of Science and Industry, results which could not have been attained unless the Scientist and the Manufacturer had been content to pool their knowledge and experience for the benefit of the common cause.

Method of co-operation.

8. The key-note of success is, therefore, co-operation and the main question of how this can best be attained must be answered by different countries in different ways. It

is, of course, unnecessary at this stage to insist on the value of research in connection with the development of new and the improvement of old industries. No manufacturer whose work depends on Chemistry for its basis, and there are few industries which do not fall within this category, would hesitate at the present time to dispute the statement that, without continual and intelligent research, improvement in existing industries and the development of new ones is impossible. The main questions are therefore:—

(1) how is such research to be carried out ?

(2) how are the results to be presented in such a form as will render them intelligible and useful to the manufacturer ?

and (3) in what manner should existing knowledge be applied in order to develop new industries ?

Research laboratories in works.

9. In a country such as England, and to some extent also in India, the more enlightened manufacturers have their own research laboratories staffed by their own chemists and in them important discoveries are often made, the results being placed on a commercial basis and worked either by patent or in secret for the benefit of the firm concerned. No service or organisation for research can, or should, alter this and it is in the interests of the country as well as of the firms themselves that such work should continue as hitherto to be carried out by them in their own laboratories. But there are numerous problems arising out of the works practice which it does not pay the firm to investigate. Such problems may or may not be of fundamental importance, but they are passed over because there is no immediate prospect of making the results

remunerative. It is indeed often possible that the very existence of such problems may be lost sight of, owing to the absence of some one competent to recognise their presence. There are, moreover, many smaller firms, and possibly some larger ones, which deal with manufacturing processes that pay them sufficiently well to enable them to ignore the intimate relation of science to their manufactures and which neither employ chemists nor consider that such employment would in any way benefit them. Such an attitude is, of course, often due to ignorance of what science can do for them and is usually engendered by a complete misunderstanding of the meaning of the term "Research." There is also a number of people who are willing to embark capital and energy in the development of some new industry, but who are deterred, not only by a lack of knowledge of the processes involved, but also because they have no means of weighing the risks they must run against the profit they may gain. If we hold the view that it is in the interests of the State as well as of the manufacturer to develop the industries of a country, it follows that the State must take some means to convince him and to demonstrate the value of research in relation to manufacture. In England where there are many firms dealing with the same industry the problem is being met by the formation of Research Associations in the various branches of industry. Such Associations receive financial support from the Department of Scientific and Industrial Research to an extent which varies with the nature of the industry, but usually amounts to £1 for each £1 subscribed by the firms forming the Associations. The payment by the Department is for five years, by which time it is hoped that the members of the Associations will have realised the value of research and that

The State and Research in England.

the Associations will have become self-supporting.

The State and Research in India.

10. This is no doubt the best method for dealing with a country such as England, where the industries are in a highly developed condition, but here in India the situation is quite different. In India the enormous natural resources are comparatively speaking undeveloped. Here and there one finds certain enlightened firms making vigorous efforts not only to render the country self-supporting, but to place it in a position to become one of the leading exporting nations of manufactured goods in the world. But there is, in our opinion, no doubt that at the present time India is not in a position to adopt the plan which is proving so successful in England, and that a more intimate system of State assistance will be necessary.

During the President's tour through the various Provinces of India, this point was made clearly evident to him. It was clear that while a great proportion of the necessary work remained undone owing to the lack of any effective organisation for carrying it out, the need was so apparent that some of the more pressing problems were being attacked by bodies which were not efficiently equipped for the work. We found for example that the Forest Department had in contemplation the erection of machinery and plant for the purpose of investigating the possibilities of manufacturing paper derived from forest grasses, and of match making, and for the extraction of essential oils and tannins. It is evident that these problems could best be attacked by a Department of Chemistry were such available. This question is dealt with again later under the heads of Agricultural and Forest Chemistry (see chapters IV and V).

11. In drawing up a scheme for the organisation of a Chemical Service which would have an effective influence on the development of the industries of this country we have borne in mind four points, namely:—

Methods for promoting industrial development in India.

(1) the need for separating, as far as possible, problems of immediate practical importance from those of fundamental character requiring prolonged scientific research before they can be adapted to industrial conditions,

(2) the necessity of so arranging matters that while local institutions dealing with the problems of immediate practical importance are in close touch with the industry, a Central Institute dealing with the more abstract questions should be established, which should be in close touch with the local Institutes and assist them in the solution of problems which were not of immediate importance but which were yet fundamental in character and of basic importance to industry generally,

(3) that while what may be termed an upstream from the factory through the local Institute to the Central Research Institute should be thus maintained, there should, at the same time, be a downstream from the Central Institute through the local Institute to the factory, carrying with it material for the establishment and development of new industries,

and (4) the need for establishing a Central Institute which should not only act in an advisory and

co-ordinating * capacity to the local Research Institutes, but should keep in close touch with the development of Science and Industry throughout the world.

For these reasons we are led at once to discard the proposal for the establishment of a single Research Institute for all India because, in our opinion, such an Institute would not only be without the necessary antennae to keep it in touch with industrial conditions but would rapidly die of starvation, through lack of scientific and industrial nutriment.

For similar reasons we are opposed to the establishment of local Research Institutes without some co-ordinating and advisory centre, because such local Institutes might neither have the time nor the inclination to deal with those fundamental problems upon the solution of which the effective development of all industries are based.

Imperial or Provincial Institutes ?

12. Our first idea was, therefore, to establish a Central Imperial Research Institute with subsidiary institutes located at suitable centres, but during the President's tour it became evident that such a scheme would not receive support. It was found, for example, that each Province desired to have its own Research Institute under its own administrative control and did not wish to have in its midst an Institute controlled from a distance which might not be in touch or sympathy with local conditions.

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*The term "co-ordination," as used in the report, means co-ordination through the medium of discussion, conference, and correspondence. It does not mean, nor is it intended to imply, that co-ordination shall be effected by the exercise of official control.

This is a view that we feel ourselves bound to accept. In every Province, both among Indians and Europeans, there was found a keenness and appreciation of the needs of the country which was not only very welcome, but which augured well for the future. They desired to get things done and were only anxious to be told how to start. In our opinion the scheme described below for the establishment of a Chemical Service is the one best suited to the peculiar conditions which prevail in India and the one which is best fitted to take advantage of and to utilise, for the benefit of the country generally, the great enthusiasm for development which exists in the Provinces. We hope and believe that at no distant date means may be found by which the Indian States may be included in the scheme. If this hope were to be realised, the Chemical Service would become "all-India" in fact as well as in name.

CHAPTER III.

The Development of new and the Improvement of old Industries.

13. We are of the opinion that these two objects, which are the basis of all industrial development, can best be effected by means of a Chemical Service constituted as follows :

The establishment of Research Institutes.

There shall be in each Province near the main centre of industry with, if necessary, sub-stations at other industrial localities of the Province, a Research Institute under a Director of Research. Such Institutes for administrative purposes will be under Provincial control. There shall also be a Central Imperial Research Institute under a Director General of the Chemical Service who shall have under him four or more Deputy Directors in charge of various branches of chemistry as hereinafter described. Should any Province not find itself in a position to erect a Provincial Research Institute or to employ a Director of Research, it shall be open to the Director General to recommend the erection of an Imperial Institute in that Province and to place in charge thereof a member of the Chemical Service as Director. An Institute of this kind would be handed over to the Provincial authorities when desired.

Provincial Research Institutes.

14. The function of these Institutes will be as follows :—

Functions of Provincial Research Institutes.

(1) to maintain close touch with the works chemists and with the works generally and to work out any problems which may be submitted to them,

(2) to develop and place on an industrial scale new industries which have been previously worked out on the laboratory and "semi-large" scale by the Central Imperial Institute,

(3) to carry out such other work as may be necessary to establish and foster new industries peculiar to the Province,

(4) to carry out such analytical work of a chemical character as may be required in the Province,

and (5) to erect and control sub-stations in such parts of the Province as the development of industry may require.

15. As regards (1) above, the question was asked by several manufacturers whether they would be allowed sole use of any discoveries which arose from problems supplied by them. The answer was, of course, to the effect that, as the work would be done at the public expense and by a public service, the results would have to be made public. On the other hand it was pointed out that it would be possible to delay publication for

Publication of work done for private firms.

an agreed period in order to enable the firm which had supplied the problem, and which was, therefore, entitled to the first use of the solution, to place the discovery on a manufacturing basis before it was made public. It was generally agreed that some such system might meet the case.

16. In practice it will usually happen that the chemist or chemists who have been engaged on the solution of the problem in the Provincial Research Institute will be lent to the firm in order to place the solution on an industrial scale. Such chemists would be seconded for service with the firms and would be paid an agreed sum by them during the period of service.

Temporary loan of chemists to private firms.

Similarly it will be open to the Director of Research to suggest to any manufacturer, who requires information on the working of any particular process, that such information can best be supplied by lending him the services of one or more chemists for an agreed period of time. Chemists so lent would be paid an agreed salary by the manufacturer during the period of their service.

17. In relation to (2) above, it would be one of the functions of the Central Imperial Institute to carry out research on the creation of new industries. These would be developed so far as the "semi-large" scale and would then be sent, usually in charge of the chemists who had worked on the problem in the Central Imperial Institute, to the appropriate Provincial Institute for conversion to the large scale. During the time these chemists were employed at the Provincial Institute

Research on new industries.

they would be paid by it and would in fact be seconded for service with the Provincial Institute. The employment of these chemists would be at the option of the Provincial Institute.

18. It is not intended that a Research Institute should act as a manufacturing body working for gain in competition with any existing manufacturer or with any manufacturer who might subsequently start work. The Committee do not consider that it is either desirable or necessary that the State should undertake such enterprises, excepting in the case of materials that are of national importance in time of war such as cordite and high explosives.

Pioneer factories.

It should be the object of the Chemical Service to hand over to private enterprise a manufacturing process, complete with plant and material, as soon as it had reached a paying basis, and to lend chemists for the purpose, if desired. The price to be paid by the purchasing firm would be a matter for arrangement and would depend on the cost of the experiment. The chemists seconded to the purchasing firm under this arrangement would retain a lien on their posts in the Chemical Service for the period for which their services had been lent by the Local or Imperial Governments. The results of their work while so employed would not, therefore, be available for publication without the consent of the firm. In some cases, especially in relation to the development of new industries depending on the application of known processes, such as for example the manufacture of silica bricks, the firm intending to undertake the manufacture would apply to the Provincial Director of Research

Position of chemists in pioneer factories.

who, if he had no one possessing the requisite knowledge available, would pass on the application to the Central Imperial Institute which in its turn, if it had no one of suitable training on its staff, would ask the Department of Scientific and Industrial Research in England to recommend some person competent to afford the necessary assistance. A person so recommended would be temporarily attached to the Chemical Service and would be paid an agreed sum by Government for the period of his employment. A portion (say one half) of this payment would be recovered from the firm making the application, but, as it is intended that the temporary member should be associated with one or more chemists of the Service during the progress of his work, it is evident that the knowledge gained by the Service Chemists would warrant the payment of half the fee. In this way it is hoped that touch will be maintained with the Research Associations in England. The establishment of a new industry based on known data may not only arise through the application made by a commercial firm, but may often be suggested by the *personnel* of the Research Institutes. In such cases the procedure outlined above should be adopted. We consider that, when dealing with the establishment of industries based on processes already known and successfully worked elsewhere, the main point is to get the process started even if the initial methods used, although good, may not be those best suited for the prevailing conditions. Once an industry has been started on reasonably satisfactory lines, it can then be improved by research. But, if a start is postponed until research has determined the conditions which are absolutely the best, it is likely that the start may be

Establishment of industries by known processes.

Special recruitment of chemists.

delayed indefinitely. It may happen therefore that the person employed temporarily for service in the establishment of a new industry based on a known process may not necessarily be a chemist in the strict sense of the term, but may be a man of the expert foreman type who has special knowledge of the technique of the process.

Manufacture on unit scale in Provincial Institutes.

19. It would be the duty of the Provincial Institute to carry out the unit scale commercial production, at the same time working out the costs and profits. If at this stage no manufacturer can be induced to embark on the venture and if, in the opinion of Government, the manufacture is one of sufficient importance, it will be necessary for the Institute itself to carry out the operation on the complete factory scale in order to demonstrate the possibilities of the process.

It is evident, therefore, that the Provincial Research Institute must not only be equipped with laboratories for small scale work, but must be prepared to carry out operations on the unit factory scale. It may sometimes happen that some factory in the neighbourhood may be equipped with plant capable of use for the purpose, but, as a rule, this plant would have to be erected and supplied by the Provincial Research Institute and would in the case of a successful experiment become one unit of the new factory.

It is also evident that the Director of Research must be a chemist who has had charge of large scale work and who is conversant with large scale operations. With him must be associated a number of junior chemists and one or two engineers of experience. It is obvious that a well equipped workshop must be attached to each Provincial Institute. Fortunately the war has produced a number of chemists of the type required as

Research Directors ; men who besides having a sound training in Science and the methods of Scientific Research have, at the same time, acquired by reason of their association with war chemical manufactures, an intimate knowledge of the successful working of large scale processes. There are some such men in India and these can be recruited at once as Directors of Research ; others of the same type who have made good in similar posts in England must be induced to come here to help in the development of the country.

The Central Imperial Research Institute.

20. The functions of the Institute will be mainly as follows :—

Functions of the Central Imperial Institute.

(1) to create new industries and to carry out the development of new processes up to the "semi-large" scale, or further if necessary,

(2) to investigate those problems of a fundamental character arising from the work of the Provincial Institutes which have been transferred to the Central Institute by the Local Director of Research in consultation with the Director General. Such problems will be those which have no apparent immediate practical importance, but which, in the opinion of the Director General and the Director of Research, are likely to lead to discoveries of fundamental industrial importance affecting the industries of the country generally,

(3) to assist in the co-ordination of the work in progress in the Provinces, both by means of personal discussion between the officers of the

Central and Provincial Institutes, during the course of the tours made by the Director General and the Deputy Directors, and by means of periodical conferences of Provincial and Imperial officers,

(4) to carry out such analytical work as may be required and to correlate the methods of analysis in general use throughout the country,

(5) to maintain a Bureau of information and Record Office,

and (6) to issue such publications as are considered necessary.

Organisation of the Central Research Institute.

21. The Director General of the Chemical Service will also be Director of the Central Research Institute and the Institute will be divided into a number of departments each under a Deputy Director. Each department should have its scientific laboratories and its "semi-large" scale laboratory for, as a rule, the further elaboration of a process to the full commercial scale will be passed on to the Provincial Research Institute concerned. It might, however, be necessary in some cases, especially in dealing with work of an all-India character to carry out experiments on the full industrial scale. Such a case would be of infrequent occurrence, as it is unlikely that investigations of this nature could not be assigned to some particular Province; and, therefore, generally speaking, the work of the Central Imperial Institute will stop at the "semi-large" scale stage.

On the other hand, if the position of the Central Institute is located, as is recommended, at Dehra Dun, it

may be desirable to carry out there the large scale chemical work of an all-India character associated with the utilisation of forest products. A description of the work is given in the Government of India despatch No. 495 of 1919, which mentions paper making, match making, the isolation of essential oils and of tannin materials and the extraction and utilisation of the vast number of organic products which can be isolated from material obtained from the forest (see also paragraph 32).

Board of Control of the Central Research Institute.

22. The general work of the Central Imperial Research Institute will be controlled by a Board comprising the Deputy Directors and such other persons as the Government of India may determine. The Board will be termed the Board of Control and the Director General will be Chairman of the Board.

The Relationship between the Central Imperial Institute and the Provincial Research Institutes.

The relation of the Director General with Provincial Research Institutes.

23. The Central Imperial Institute would have no administrative control over the Provincial Research Institutes, but we would recommend that no appointment as Director of Research in the Provincial Institutes should be made without consulting the Director General. It is desirable that the Director General and the Deputy Directors should visit Provincial Research Institutes and co-ordinate the work done in each. They would, when requested by the Directors of Research, decide whether any problems presented to them were of sufficient fundamental importance to warrant their transference to the Central Research Institute for thorough scientific investigation. They would also

ascertain the progress which had been made in the application of any new industrial process, initiated in the Central Institute, to commercial conditions.

Position of chemists in Provincial Research Institutes.

24. The chemists employed at the Provincial Institute would be members of the Chemical Service and would be seconded for service under the Provincial Governments and be paid by them. Once a chemist has been seconded for service in a province, he would not be transferred, except for the purpose of promotion, without the consent of the Local Government concerned. On the other hand, if a man so seconded were found unsuitable, he could be replaced by another, and the unsuitable member would be withdrawn to the Central Research Institute for employment either there or elsewhere, at the discretion of the Director General.

Appointment of staff at Provincial Research Institutes.

25. The staff of the Provincial Research Institute would, in the first instance, be appointed by the Local Government in consultation with their Director of Research and the Director General. Ultimately the staff would be recruited from the Chemical Service although it would be open to the Local Government to recruit for special purposes from outside the service, subject to the concurrence of the Government of India. This point is dealt with more fully in the paragraph concerning recruitment (paragraph 86).

CHAPTER IV.

The Relation of the Proposed Organisation to the Department of Agriculture.

The inclusion of agricultural chemists in the Chemical Service.

26. The chemists employed by the Department of Agriculture have considered the question of their inclusion in the Chemical Service on more than one occasion,* and their opinions and decisions have been placed on record and forwarded to us for consideration.

The general view appears to be that it is undesirable to include agricultural chemists in the new Service, because such inclusion would entail a break with the existing organisation and would, if extended to the other scientific branches of Agricultural Research, shut each officer in the water-tight compartment of his own service and tend to make more difficult that collaboration between the different scientific officers which is essential for success. It is also held that the separation of these officers into distinctive services would destroy the *esprit de corps* of the Agricultural Department.

It is obviously undesirable to remove the agricultural chemist from his agricultural atmosphere and it is obviously necessary that he should continue to carry out his work in close contact with the botanist, the agriculturalist, and other officers who are also investigating agricultural problems. For these reasons it is just as

*(1) Proceedings of the First Meeting, Pusa, 24th February 1919.

*(2) Resolution of the Second Meeting, Pusa, December 1919.

undesirable to remove agricultural chemists from the agricultural centre at Pusa to the Central Imperial Research Institute, as it would be to interfere in any way with the existing provincial arrangements for agricultural research and teaching.

It is evident to us that a reorganisation of the scientific departments attached to the Agricultural Service is impending and inevitable. Many views have been expressed by both agriculturists and scientists attached to the Agricultural Department and the general opinion seems to be that the solution lies in the establishment of separate research sections in which the appropriate scientific officers would be grouped for the study of well defined major problems, rather than in the formation of separate scientific services. It seems to us that to express any opinion on the advantage of either method is beyond our remit and we, therefore, consider it desirable to recommend that the inclusion or otherwise of the Agricultural Chemists in the Chemical Service should await the decision of the Agricultural Department upon this point.

Future inclusion of agricultural chemists in the Service.

27. If this decision be in favour of the formation of Scientific Services it will be an easy matter to include agricultural chemists in the Chemical Service when such decision is reached. If, on the other hand, it is decided that the alternative method should be given a trial, arrangements can be made to second chemists from the Chemical Service for employment in the Agricultural Department, if thought desirable. If not, the Department may recruit in any other manner that it considers expedient. Should the Agricultural Chemists become members of the Chemical Service, difficulties would probably arise through the fact that,

for purposes of administration, chemistry and agriculture would be attached to separate Departments of Government, but these difficulties might be minimised if, as we recommend later, (paragraph 73) Agriculture could be placed under the same Member of Council as the Chemical Service. On the other hand, the transference of agricultural chemists to the Chemical Service would prejudice their present prospects of filling the higher posts in the Agricultural Service and it is open to question if these could be adequately compensated for by opportunities for promotion in the new service.

We would also point out that a great part of the work of the Department of Agriculture is educational and that, as will be shown later, it is not proposed that the new Chemical Service should touch educational matters. This is an additional argument against the inclusion of agricultural chemists in the Chemical Service, but we understand that the trend of development is to separate the teaching of agricultural chemistry from the other duties of these officers and, if this separation is effected, the objection would disappear.

Agricultural chemists not to be Members of the Chemical Service.

28. In view of these considerations, and of the opposition of the Agricultural Chemists to inclusion in a chemical service, the Committee are unable to recommend their inclusion. There are, however, many points of contact and many ways in which this particular branch of chemistry can help and be helped by other sections of the science, and it should not be impossible to arrange for a mutual interchange of information, as it would be unfortunate if agricultural chemists were not in touch with the chemical

development of the country generally and if the Chemical Service were not acquainted with the various advances made in agricultural chemistry.

Chemical Exploitation of Agricultural Products.

29. In subject IX paragraph 14 of the list of resolutions passed at the First Meeting of Agricultural Chemists and Bacteriologists at Pusa, on the 24th of February 1919 and the following days, it is stated :—

> "That this meeting recognises the need for the "development of work on industrial problems "arising out of research work initiated in "agricultural laboratories, and considers that "such work could best be carried to a success- "ful commercial issue by the creation of a "technological laboratory to form one of the "special sections of the Imperial Agricultural "Department under the Government of "India."

We mention this specifically because we desire strongly to express the opinion that we do not consider it to be the function of the Agricultural Department systematically to deal with industrial research on industries subsidiary to agriculture. Problems of this kind can only be worked out in a satisfactory manner by an organisation such as we propose for the Chemical Service. On the other hand we feel that an agricultural chemist should not be debarred from developing his research work for want of the provision of a suitable laboratory, and we support the resolution with the reservation referred to above.

CHAPTER V.

The Relation of the Proposed Organisation to the Forest Department.

30. Forestry is on a different footing from agriculture and at the present time is related to chemistry only in so far as the possible utilisation of forest products is concerned. This is, in itself, an enormous field for research which has hitherto received little attention. The synthetic organic chemical industries (drugs, dyes &c.) are based upon coal-tar, mainly because in the countries in which they are worked coal-tar is readily available. Here in India coal-tar is not available in large quantities although the essential aromatic hydrocarbons are available from other sources, for example, from Borneo petroleum, and may also be produced in quantity when the coking of coal is carried out under conditions necessary for the recovery of by-products. Although therefore India may be regarded as being deficient at the present time in the raw material for the production of organic chemicals from coal, yet there is without doubt an enormous field of supply of carbon compounds in its forests and jungles.

Coal-tar industry.

We refer not only to wood distillation and the development of industries based on the utilisation of the by-products obtained therefrom, to the manufacture of indigenous dyes, medicinal drugs and essential oils from Indian raw materials, to the refining and utilisation of fixed oils, but also to the conversion of organic compounds present in Indian plants into products of greater economic value. The last-mentioned problems are primarily questions of pure research and could best be dealt with

Forest resources.

at the Central Research Institute or in University laboratories, the necessary raw materials being supplied by the Forest Department.

It cannot be too strongly emphasised that the effective utilisation of forest products often depends upon chemical examination *in situ*. It has been customary hitherto to send specimens to Dehra Dun for examination and even in some cases to the Imperial Institute in London. Although usually the examination of such specimens will supply data more or less in agreement with the composition of the material as first gathered, yet it cannot be assumed that this is always the case and it is probable that much false information has been acquired owing to the deterioration or change in composition of the specimen on long keeping. This has long been recognised in the case of sugar-cane and is undoubtedly true of many natural organic products.

Chemists in the Forest Department.

31. For this type of work it is clear that chemists must be seconded to the Forest Department and must work in the forests or in some convenient locality near to. They must be provided with travelling laboratories, on rail or motor, adequately equipped for the purpose of carrying out small scale experiments, the main chemical work being transferred to the Central Imperial Institute. There is urgent need for a systematic chemical survey of the forests and it is essential that such a survey should be carried out by chemists in close collaboration with botanists.

In the absence of Departments of Industries and Departments of Research, the Forest Department has anticipated the Industrial Commission's Report and has done excellent pioneer work both with regard to turpentine, rosin and paper pulp. The factories at Bareilly

and Jallo are an excellent demonstration of what a Government department can do, and the Forest Department is to be congratulated on having led the way in the industrial development of the country through the agency of the State.

Now that the Industrial Commission have recommended that special Departments of Industries should be created, one of the main functions of which will be the pioneering of industries, work of this nature will be transferred to the Directors of Research. In Mysore, where a Department of Industries was in being, the distillation of sandalwood was undertaken by the Director of Industries and not by the Forest Department, which is directing its energies to the culture and isolation of the sandalwood. We do not propose that the pioneer factories which are already in existence, such as those at Bareilly and Jallo, should now be handed over to the Department of Industries; for we consider that their purpose has been served and that, if suitable terms can be arranged, industries so well established, as these appear to be, should be transferred to private management. Should it be impossible or impracticable to transfer these industries to private hands, they must be retained under State control.

Chemical Exploitation of Forest Products.

32. In Despatch No. 495 of 1919 to the Secretary of State on the expansion of the Forest Research Institute at Dehra Dun, proposals are made for the erection and equipment of large scale laboratories for the treatment of paper pulp. It is stated that the cellulose expert (Mr. Raitt) is now in England "with a view to obtaining special plant for the investigation of the problem of utilising the

Paper Pulp.

"" enormous quantities of grass, bamboos and other ma-
"" terials available for the manufacture of paper pulp."
We have already, (paragraph 30), stated our view that this problem could best be attacked by the Organic Chemistry Department of the Central Imperial Institute, and we therefore recommend that the services of Mr. Raitt should be transferred to the new Chemical Service and that his proposed plant and laboratory should be erected in some position adjacent to the organic laboratory of the Central Institute (see paragraph 53). It is also recommended that all questions of the isolation of essential oils should be dealt with by the same Deputy Director. Match making is another industry the development of which we understand the Forest Department has under contemplation. Here again the treatment of the wood and the provision of the igniting materials is essentially chemical and we recommend that this problem should also be transferred to the Chemical Service. It is, of course, desirable that all these operations should be carried out in close collaboration with the Forest Department and this can be readily effected if, as is hereinafter recommended, the Central Imperial Institute is located at Dehra Dun.

CHAPTER VI.

The Relation of the Proposed Organisation to the Education Department and Educational Institutions.

33. It has already been mentioned that the main object of the Chemical Service will be to foster research. It is not proposed to institute any system of training, unless in the earlier stage of development such training is necessary for the purposes of recruitment. It is evident, however, that important practical training will accrue during the ordinary working of the Service.

Qualifications of recruits for the Chemical Service.

For the purposes of recruitment it is considered that the following qualifications should be insisted on—

(1) an Honours' degree in the 1st or 2nd class or its equivalent,

(2) a suitable training in engineering (workshop practice, and machine drawing),

and (3) one or two years' training in the methods of research under a professor or teacher of a University or University Institution who is competent to train in research.

Maintenance grants.

34. For the purposes of (2) and (3) above we recommend that the Government of India and the Local Governments should provide maintenance grants for promising

students.* The Committee believe that the engineering training under (2) above will ultimately form part of any recognised Honours' Course in Chemistry, but, until it does, they are prepared to insist that such training should be given subsequent to graduation. In their opinion it is quite unnecessary for the purposes of the scheme for a chemist to be an expert engineer or for an engineer to be an expert chemist, but it is essential that each should know enough of the science of the other to understand its language. One of the greatest bars to progress during the recent war was the inability of the great majority of academic chemists to think in engineering terms and for the engineer to think chemically. It was, for example, almost impossible to find a chemist who could read an engineer's drawing or who could even make a rough sketch which was intelligible to an ordinary draughtsman.

Chemists and Engineers.

35. It is gradually becoming recognised in England that an Honours' School of Chemistry should include a course in engineering, and there is no doubt that Indian Universities will quickly follow the British example when this has been set. Until then, however, recourse must be had to training subsequent to graduation, that is in the period during which the student is receiving instruction in the methods of research, and while it is obviously desirable that the two courses should run concurrently, it will sometimes happen that the absence of the necessary facilities will necessitate the two

Training of chemists in engineering.

* Equipment grants should also be given to enable students to purchase apparatus and material required by them in their work, but the apparatus and material provided in this way should not be such as would normally form part of the usual equipment of a University or University College laboratory.

being given in different places. To illustrate this we may take the case of a man who, for example, receives his training in research at the Gujarat College, Ahmedabad, and obtains his engineering instruction at the Engineering College, Poona. In this way we can arrive at the length of the course required when the student is occupied entirely with his subject, and it will then be a simple matter to indicate the number of hours of instruction necessary when he is in a position to combine the engineering training with his instruction in research. It is of interest to note therefore that Professor Graham Smith in his evidence (appendix II) considers that the necessary instruction could be imparted during a course of six months' duration and we are informed that Professor R. S. Cree Brown, Professor of Mechanical Engineering in the College of Engineering, Poona, agrees with him, provided that the students work from 7 to 8 hours daily.

Engineers both here and in England have expressed the view that it is only possible to train a man in engineering by giving him a full course such as that laid down in the usual syllabus of a recognised Engineering College. Such a course would without doubt be of inestimable value to a chemist if time would admit of his taking it, but this is obviously out of the question. Indeed, as we have mentioned above, it is not, in our view, necessary for a chemist to know more of engineering than is sufficient to enable him to understand the language of the engineer and to make himself intelligible when the two are working together.

In actual practice no recruit would be accepted for the Chemical Service, until the Head of the Engineering Department in which he had been trained had certified him as proficient to the extent required by the Service.

One of the objects of the Service will be to produce men, experts in their own line, who will advance knowledge by working in close collaboration. We consider that if a man has been thoroughly grounded in the theory and laboratory practice of his subject by passing through a recognised Honours' Course, followed by a training in the methods of research, and has acquired a working knowledge of engineering methods, he should then be in a position to think for himself and to apply his knowledge. A training in the methods of pure scientific research is, in our opinion, the best means for developing that self-reliance and initiative which are so essential to the efficiency of the true research worker. Moreover, we consider that a man trained in the manner we suggest will be in a position quickly to pick up during his employment such knowledge of large scale plant as he will require for his work, it being remembered that he will carry out such work in close collaboration with the expert engineers who will be attached to the same institution. It will, moreover, be one of the objects of the Service to transfer recruits deficient in such knowledge to a Research Institute or Demonstration Factory where it may be obtained.

Duty of Educational Institutions.

36. It is, we think, the duty of Educational Institutions to train men in the methods of scientific research and we propose to leave this training entirely to them, giving, as already indicated, maintenance and equipment grants to those students whose financial position renders such assistance necessary. It may happen that recruitment under these terms may not prove possible for some time in many parts of India, although already notable steps in the right direc-

tion are being taken, for example in Calcutta by our colleague Sir P. C. Rây. It, therefore, follows that, until the Indian Universities and University Institutions can develop their Honours' Schools of Chemistry and train men in research, we must send our students abroad to countries where an adequate training can be obtained.

Recruitment in India.

In the written evidence of Mr. Sharp, Educational Commissioner with the Government of India the following statements occur :—

> "The College Professor has often little time for research and the chief Professors, who may be styled University Professors, will be largely in the same position."
>
> "In India a member of a College staff is generally burdened with multifarious duties of College organisation."
>
> "A College Professor is in a disadvantageous position in that he has ordinarily very little or no time for research. He will ordinarily be likely to fall out of the running for the more lucrative or at least attractive posts in the Chemical Service. The Educational Service will hence become unpopular and might even form the scrap heap of the Chemical Service."

These statements give a full and sufficient explanation of the fact that hitherto real university work in India has been almost non-existent, and it is regrettable that such a state of affairs should be acquiesced in by those in charge of the Educational policy of the country. In our opinion the formation of a Chemical Service as outlined in this report would necessitate a strengthening

of the Chemical Departments of Indian Universities and University Institutions. The Professors of Chemistry would have to be relieved of some of their routine work and could then devote an appreciable amount of time to training their senior students in methods of research. In this way the Universities would be able to train men suitable for recruitment to the proposed Chemical Service. The formation of a Service for the purpose of industrial research does not mean that University Professors should be discouraged from doing similar work. The President in his introductory note has drawn attention to the importance of having attached to the Chemical Department of every University a laboratory containing every kind of plant used in chemical manufacture of about 1-60th the size of the large scale plant, and we would add that, if actual industrial problems were also under investigation in the laboratory, the value of this part of the students' training would be greatly increased.

Position of University Professors.

37. The Chemical Service will not, therefore, touch the Educational Service or Educational Institutions except in so far as concerns the efficient training of their recruits in research methods. For this reason we do not propose that professors and teachers of Chemistry should normally be members of the Service. It would, of course, be open to the Education Department or to an Educational Institution to ask for a chemist to be seconded from the Service if it so desires, but in that case the chemists so seconded would serve under the Education Department or the Educational Institution concerned. They would retain their lien on their appointment in the Chemical Service, subject to the operation of section 89 of the Civil Service Regulations* and they would have the option of transferring their

*See Appendix IIC.

services to the Education Department or to the University which they were serving, by mutual agreement. They would however be at liberty to revert to the Chemical Service, on promotion, on their own request, or on the request of the Education Department or University to which their services had been lent.

CHAPTER VII.

The Relation of the Proposed Organisation to other Departments of Government.

The Ordnance Department.

38. The Ordnance Department on the chemical side deals mainly with the manufacture of cordite and substances incidental thereto. The President has visited the factory at Aravankadu and has heard the opinion held by the chemical staff. The works are in charge of a military officer (R. A.) and the question was raised whether it was not desirable that a factory, such as this, dealing with processes based entirely on chemistry would not best be controlled by a chemist rather than a soldier. This is an old controversy and one which in our opinion can be settled in one way only. It is, of course, desirable that a man possessing high chemical qualifications should be in charge of a factory of this kind provided that he possesses also the other attributes which go to form an efficient factory director. Among these attributes must be placed the possession of the right temperament and the power to control men. It generally happens that these accomplishments are more often possessed by the military officer than by the chemist but *ceteris paribus* we strongly recommend that an appointment of this kind should in future be given to a chemist. An example of the advantage of employing a chemist possessing the qualifications we have mentioned, as head of a factory dealing with chemical processes, is supplied by

Recruitment of Superintendents of Ordnance Factories.

Acetone Factory at Nasik.

Nasik, where plant for the preparation of acetone by the fermentation process has been installed during the war. We are convinced that this exceedingly difficult operation would not have been carried to a successful issue, had it not been controlled by a chemist assisted by an efficient staff. We consider that all chemists employed under the Ordnance Department should be seconded from the Chemical Service.

The Chief Inspector of Explosives.

39. We understand that this post has hitherto been held by a military officer (R. A.). Subject to the remark we have made in the preceding paragraph that the officer appointed must possess the necessary *savoir faire*, we are strongly of opinion that a chemist having a knowledge of explosives and allied substances should occupy this position and that he should be a member of the Chemical Service.

Assay Masters.

40. In Resolution No. 1168, dated the 28th July 1919, of the Finance Department of the Government of India, a new scheme of recruitment for Assay Masters and Deputy Assay Masters has been promulgated. We consider that these posts should be held by officers drawn from the Chemical Service, who will draw their grade pay in addition to such Presidency allowances as are, or may be, granted to officers serving in the Mints.

Major Willis, in his written evidence,* has advocated that the present system, under which the Assay Master is to all intents and purposes independent of the Mint Master, should be revised and that the former should be

placed in direct subordination to the Master of the Mint. With this suggestion we are in agreement.

The Medical Stores Department.

41. The work of this Department has developed considerably during the war, its object being to ensure the supply of essential drugs and other medicinal appliances. The Department has carried out very useful work and is still doing so and we are of the opinion that nothing would be gained by disturbing its activities. We think, however, that the chemists employed should be seconded from the Chemical Service and that the records of the Department should be available for the use of the Service.

There are many questions involving research which can best be dealt with at the Central Institute, and which can be transferred thereto by arrangement with the Director General.

Geological Survey and other Government Departments employing Chemists.

42. Chemists should be seconded for service with these departments under the general terms given in paragraph 86.

Chemical Examiners, Customs, Excise, Public Analysts.

43. These appointments are dealt with in the following chapter.

CHAPTER VIII.

Analytical Chemistry.

44. It is suggested that one of the Deputy Directors should be placed in charge of Analytical Chemistry and should have at his disposal at the Central Imperial Research Institute a laboratory for Analytical Chemistry with a staff of analysts. Part of his duties would be the analysis of stores and he would also co-ordinate methods of analysis and if necessary introduce new ones. He would act in an advisory capacity to the various Provincial Government Analysts who, it is suggested, should be attached, one to each Provincial Research Institute.

Chemical Examiners.

45. At the present time chemical analytical work in the Provinces is, as a rule, performed by the Chemical Examiners who are, with one exception, officers of the Indian Medical Service. There are in addition in certain Provinces, Customs, Excise and Public Analysts' laboratories, whilst the Imperial Government maintain the Government Test House in Calcutta and a metallurgical laboratory at Jamshedpur. The Government Test House in Calcutta was originally started by the Railway Board for the testing of railway materials purchased in the country, but it has, during the war, entered upon a much wider sphere of activity. At the present time the work of the Chemical Examiner is twofold, namely, that of a purely chemical character and that which requires medical as well as chemical knowledge. He is in addition usually Professor of Chemistry in

Government Test House. Metallurgical Inspector.

the Medical College. It is suggested that the Professor of Chemistry in the Medical College should continue to perform those duties of the Chemical Examiner which require medical knowledge and that he should be styled "Government Toxicologist."

Government Analysts.

46. We recommend that chemical analytical work in the Provinces should, so far as possible, be concentrated in a Government Analytical Laboratory, attached to the Provincial Research Institute, which would be under the control of the Director of Research. We consider that this would make both for economy and efficiency. The Government Analyst might also undertake private analytical work at a scale of fees to be determined subsequently.

With the increased purchase of Government stores in India and the introduction of Foods and Drugs Acts, the work of these laboratories will undoubtedly be very heavy, and we consider it to be a matter for future consideration whether they should also undertake analyses for Municipalities and Local Boards.

Standardisation of Exports.

47. There is one important point which we desire to raise and which could easily be met by an organisation such as we contemplate. It is the question of the standardisation of exports, as is done in Australia and in the United States of America. Although we do not wish to express any opinion as to the desirability or otherwise of effecting such standardisation, as it is beyond our remit to do so, we desire to point out that, if certificates of purity are desirable, it would be an easy matter to arrange for their production either Imperially or Provincially.

CHAPTER IX.

The Indian Institute of Science, Bangalore.

48. The proposals of the Council of the Institute with regard to its future development have been forwarded to us by the Government of India for consideration. These proposals are not in entire consonance with the original intention of the Founder, or with the prescription of the Vesting Order which declares that the Institute should be devoted to "the promotion of original investigations in all branches of knowledge and their utilisation for the benefit of India." The Council now proposes that the Institute should concentrate on one branch of Science, *i.e.*, Chemistry, and that it should be converted into a Central Institute devoted to chemical research in all its branches. So far therefore the proposals of the Council are in agreement with our own proposal that a Central Chemical Institute should be established in order to further the industrial development of India through the medium of chemical research. The proposal of our Committee however implies and necessitates that the Central Research Institute should be under the control of the Government of India and form the pivot of the Chemical Service. The scheme put forward by the Council of the Institute does not admit of such Government control.

During the course of his tour the President visited Bangalore, where he met several Members of the Council. He also discussed the question with Sir Dorabji Tata. These discussions, so the Committee are informed,

have rendered it clear that the Council is opposed to the transfer of the Indian Institute of Science to the Government of India either with or without the endowment. Had the Council been agreeable to this proposal, we should have recommended that the Institute at Bangalore be taken under the direct control of the Government of India and utilised as the Imperial Chemical Research Institute. In the absence, however, of any such offer, we are unable to make use of the Indian Institute of Science in connection with our scheme and must leave it to the Council of that Institute to formulate, after perusal of our report, such further proposals as may seem to it requisite.

CHAPTER X.

The Location of the Central Imperial Chemical Research Institute.

Climatic comparison of Dehra Dun and Bangalore.

49. We have considered the various alternatives which have been suggested to us and have come to the conclusion that we must endorse the recommendation of the Industrial Commission that Dehra Dun should be the site of the Central Institute. Dehra Dun has a climate very similar to that of Bangalore, as the following figures obtained from the Meteorological office show :—

NORMALS.

Month.	Bangalore.				Dehra Dun.			
	Maximum temperature.	Minimum temperature.	Relative humidity at 8 hours.	Rainfall.	Maximum temperature.	Minimum temperature.	Relative humidity at 8 hours.	Rainfall.
	°	°	%	"	°	°	%	"
January	80·7	57·4	79	0·25	66·2	44·8	79	2·35
February	86·0	60·0	71	0·16	69·2	47·0	74	2·49
March	91·0	64·7	64	0·55	79·7	55·0	57	1·26
April	93·3	69·3	71	1·36	90·6	64·3	46	0·71
May	91·6	69·2	75	4·16	95·0	70·5	46	1·42
June	84·9	66·9	80	2·94	93·0	74·4	70	8·64
July	82·1	65·9	85	4·23	85·5	74·1	88	25·52
August	81·9	65·8	85	5·19	84·0	73·1	90	29·69
September ...	81·9	65·4	86	6·95	84·3	70·0	83	9·45
October	81·9	65·1	82	6·18	82·3	66·0	68	0·90
November ...	79·6	6 ·9	78	2·66	75·0	51·8	71	0·42
December ...	78·5	58·5	79	0·46	68·7	45·6	75	0·81
Year ...	84·5	64·2	78	35·10	81·1	60·9	71	83·66

As regards health conditions the incidence of malaria does not seem high, and the nearness of Mussoorie renders temporary escape from unpleasant climatic conditions readily possible. The great advantages which Dehra Dun possesses over Bangalore lie, however, in its proximity to Simla and Delhi and in the presence of the Forest Research Institute within the same area.

Site of the proposed new Forest Research Institute.

50. In the Despatch to the Secretary of State of the 12th December 1919, to which reference has already been made, it is suggested in paragraph 11 that the present Forest Research Institute should be removed to a site of 1,200 acres at a distance of 4 miles from the town and that 200 of these acres should be allotted to the Chemical Service for the erection of a Central Imperial Institute. The President has visited this site and also the existing Forest Research Institute, and we have reached the conclusion that the problem would be best solved by transferring the present Forest Research Institute, as soon as practicable, to the Chemical Service for use as the Central Imperial Chemical Institute, leaving the Forest Department to erect their new Forest Institute on the proposed site of 1,000 acres.

Reason for choice of site.

51. We are prompted to recommend this plan because we realise that much time would be saved in the erection of the more essential buildings of the Central Imperial Institute, if building operations were at once started on the 29·7 acres of vacant land which we understand, from the Despatch quoted above, it is possible to acquire. This, together with the existing chemical facilities, would enable the Central Imperial Institute to carry on the more pressing portion of its work until the Forest Department was in a position to hand over the whole of their estate of 47.8

acres together with the existing buildings. We consider that the total acreage of 77·5 acres would be sufficient for the purposes of the Central Institute and for the accommodation of the subordinate staff, provided that land could be acquired in the neighbourhood for the erection of bungalows for the Director General, Deputy Directors and other members of the superior staff.

Water supply.

52. An adequate water supply is absolutely essential for the effective working of the various laboratories which will be attached to the Central Chemical Institute and, although mention is made in the Despatch quoted above of the inadequacy of the supply on the present site, it is not specifically stated how this inadequacy is to be remedied on the new site. We understand, however, that arrangements are being made for the provision of sufficient water for the purposes of the new Forest Institute, and it does not appear unlikely that similar arrangements can be made to meet the requirements of the Central Chemical Institute.

The Central Imperial Chemical Institute would comprise a central block of buildings (the existing central block of the Forest Research Institute) which would contain—

(1) Administrative Offices,

(2) Library,

(3) Museum,

(4) Central Information Bureau and Record Office,

and (5) Office of the Director General.

53. It is probable that the existing central building of the Forest Research Institute will not be large enough for the purposes outlined above, and it is recommended that, as soon as possible, steps should be taken to build wings on both the east and west sides towards the south, and that ultimately the potential quadrangle so formed should be closed by the erection of a block similar in character to the existing block.

Extension of the Forest Research Institute Buildings.

It is recommended that in the first instance Deputy Directors should be appointed in charge of—

(*a*) Inorganic and Physical Chemistry,

(*b*) Organic Chemistry,

(*c*) Metallurgical Chemistry,

(*d*) Analytical Chemistry,

and that separate departments should be established and laboratories built and equipped for each branch. The precise details of these laboratories and their equipment must be left over until the Deputy Directors have been appointed and their requirements ascertained in consultation with the Director General; in other words until the Board of Control of the Central Institute mentioned in paragraph 22 has been established. It is recommended that steps be taken at the earliest possible moment to appoint these gentlemen. Although, therefore, it is not possible at this moment to indicate the precise requirements of each Deputy Director, it is certain that a large and well-equipped central laboratory, or series of research laboratories, will be necessary in each case and that these buildings must also include the offices of the Deputy Directors. Each building will have to be

Immediate constructional requirements.

placed on ground sufficiently large to provide for expansion, that is to say, for the inclusion of such sub-sections, for example of colloid chemistry and bio-chemistry, as may ultimately become necessary. Taking for example the case of the Department of Organic Chemistry besides the main laboratory it will be necessary to provide a "semi-large" scale laboratory equipped with all the various types of usual chemical apparatus of a size approximately 1-60th that of the normal scale plant. In addition to this it would be necessary to provide—

Department of Organic Chemistry.

(1) a laboratory for paper pulping and paper making,

(2) a laboratory for the investigation of essential oils equipped with large scale distillation plant,

(3) a dye house,

(4) a laboratory for the investigation of tanning materials,

and (5) a laboratory for the extraction of drugs and similar products.

Other requirements must be formulated later, but one essential feature of the Institute must be a fully equipped workshop, where not only can necessary repairs be carried out, but where some of the smaller types of apparatus can also be made. A foundry, forge, pattern shop, and carpenter's shop must therefore also be provided. It is evident, therefore, that a staff of engineers must be attached to the Institute, which should include a mechanical engineer, an electrical engineer and subordinate officers in charge of the foundry, forge,

pattern shop, plumber's shop, carpenter's shop and drawing office. The need for a printing press and a book-binding shop, attached to the Central Institute should not be lost sight of.

Need for a Metrological Section.

54. With the development of scientific research which will, we hope, result from the establishment of the numerous research institutes, the need will arise for a laboratory in which the standardisation of apparatus and instruments can be undertaken. Such a laboratory would more suitably form part of a research department of physics, but, in the absence of such a department, we would recommend that a small metrological laboratory should be attached to the Imperial Research Institute under the control of the Deputy Director for Physical Chemistry.

Need for a Hill-station laboratory.

55. It is well known to chemists in India that research, even at places such as Dehra Dun, is liable to interruption during the hot weather when many of the usual chemical operations can only be carried out with difficulty. If a small laboratory were equipped at Mussoorie, it would be possible to carry out there those operations which required special temperature conditions, and the proximity of the facilities at the Central Institute would enable work to be carried out under exceptionally favourable conditions. Moreover, this hill-station laboratory could be used for the purposes of research by Professors of Chemistry and others who are debarred from continuing their work during the hot weather vacation in their own laboratories.

CHAPTER XI.

The Location of Provincial Research Institutes and the Facilities for Training afforded by the Provinces.

Appointment of Directors of Research.

56. It is suggested that Provincial Research Institutes should start with laboratories equipped to deal with existing industries in the Province, but should have ample room for expansion so as to include research and demonstration work in relation to the establishment and development of new industries. The first step will be to appoint a Director of Research and this should be done at once. The Director of Research so appointed should work in close touch with the Director of Industries, but we consider that no steps should be taken towards the erection or equipment of a Provincial Research Institute until the Director of Research shall have formulated his requirements. It will also be necessary at an early date for the Director of Research, in collaboration with the Directors of Agriculture and Industries and with the Chief Conservator of Forests, to make a survey of the Province and to ascertain the new industries that may be established there.

Chemical Survey of the Provinces.

57. Each Provincial Research Institute should contain :—

(1) a well-equipped general laboratory containing sections for inorganic (including mineral) chemistry and organic chemistry,

(2) such other sections as the needs of the locality may determine,

(3) a "semi-large" scale laboratory containing apparatus of a general type about 1-60th the size of the usual large scale plant,

(4) a large laboratory equipped in accordance with the requirements of the Government Analyst,

(5) well-equipped workshops, with foundry, forge, carpenter's shop, and pattern shop attached,

and (6) the necessary administrative buildings comprising offices, library, museum, bureau of information and record office.

A staff of engineers similar to that required for the Central Institute (see paragraph 54) will have to be attached to each Provincial Research Institute.

The Position in the Provinces.

58. The following notes are given in order to indicate the general lines on which it is suggested that each Provincial Institute should develop. No mention is made of the possible industries which it is considered might be developed in each Province, because, as already mentioned, it is recommended that the Director of Research should make, at an early date, a complete survey of the field. Doubtless the Provinces will make full use of any facilities for research that are already in existence.

Madras Presidency.

59. *Location and Control of Institute.*—If the Provincial Institute is to be located within the limits of

the Presidency, the most suitable site is Madras itself, but it has been suggested to us that the research work of Madras Presidency could be carried out in the Indian Institute of Science, Bangalore. This is a question which must be left for decision to the Local Government and to the Council of the Institute.

Training.—The Presidency College is building new laboratories and there is no doubt that both preliminary training and training in research can be imparted here, if the staff is suitably strengthened. Suitable training in engineering will be obtainable at the new College of Engineering.

Bombay Presidency.

60. *Location and Control of Institute.*—The site for the Provincial Institute should be Bombay. Here we were unable to obtain an authoritative statement, but we understand that for administrative and finance purposes this Institute will be controlled by the Local Government.

Training.—Preliminary training on the lines of an Honours' degree forms part of the University curriculum, the B. Sc. degree with Chemistry as main, and Physics as subsidiary, subjects being suitable, while the necessary engineering training can be obtained at the Engineering College at Poona. It is possible that this training may also be given by the Victoria Jubilee Technical Institute, when it has moved to its new quarters. The main difficulty in this Province is the lack of adequate provision for training in research. At the present moment this can only be obtained at the Gujarat College of Science at Ahmedabad, because the position of the College of Science, which should be the

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real research centre of the Province, is still undefined and its relation with the University undecided. If this College is attached to the University and the Chemistry Department is placed in charge of a research chemist of standing, it would no doubt play an important part in the training of recruits for the Chemical Service.

Bengal Presidency.

61. *Location and Control of Institute.*—The site of the Provincial Institute should be Calcutta, although the need for sub-stations in other parts of the Province will no doubt arise later. It is understood that for the purposes of administration and finance this research institute will be controlled by the Government of Bengal, although we were unable to obtain a definite statement to this effect from the Government.

Training.—Conditions for training students for recruitment into the Chemical Service are undoubtedly further advanced in this Province than in any other. Preliminary training on the lines of an Honours' degree and subsequent training in the methods of research are provided in the Presidency College and in the University College of Science. There is also ample opportunity for the necessary training in engineering at the Engineering College at Sibpur. There is, moreover, the University of Dacca in which no doubt recruits can be suitably trained.

Bihar and Orissa.

62. *Location of Institute.*—The chief manufacturing centre of this Province is Jamshedpur, but the area of mineral deposits and of industries based thereon extends

into other parts of Chota Nagpur, and to the adjoining tract of Bengal. We, therefore, consider it inadvisable to locate the Research Institute at the centre of any particular industry or group of industries, such as Jamshedpur, Dhanbad or Asansol, and prefer to recommend that the Institute for chemical research connected with these seats of industries should be located in Ranchi, which, in addition to being situated within easy reach of all the areas referred to, possesses the advantage of a climate in which research work can be carried out all the year round. Purulia is geographically a convenient centre, but the inferiority of the climate, and the fact that Purulia is of itself of little importance, compel us unhesitatingly to declare for Ranchi as the most suitable location. Ranchi is connected with the centres of industry by first class roads and it is intended to convert the narrow gauge railway on which Ranchi is situated to the broad gauge, and to carry through the connection to meet the main line in the Central Provinces. Ranchi is, therefore, not only accessible now both by road or rail, but it will become at an early date much more accessible both from the point of view of the industries themselves, and of the commercial centre on which the industries are based, Calcutta.

Control of the Institute.—The Government of Bihar and Orissa have, through their representative, expressed themselves unable to finance a Research Institute in their Province. They welcome, however, the foundation of such an Institute and desire if possible to be associated in its control. The Institute will deal with the industries of a well defined area of Bengal, and it may be that the Bengal Government may also desire to share in the control, but the subject is one with which we do not feel ourselves qualified to deal, and, while we recommend the immediate establishment of an Institute by the Imperial

Government at the heart of the mineral and metallurgical industries of India, we feel that the question of the division of control must be left to the decision of the Imperial Government.

Training.—The new University Science Laboratories at Bankipore will afford ample facilities for the training of chemists on the required lines.

United Provinces.

63. *Location and Control of Institute.*—Steps have already been taken to erect a Research Institute at Cawnpore, the industrial centre of the Province, and a Research Director has been appointed subject, we understand, to the approval of the Secretary of State. There is no doubt that sub-stations will also be necessary in other parts of the Province.

Training.—The Muir Central College, Allahabad, is suitable for training recruits, and this will also be the case with the new University of Lucknow when it is created.

Punjab.

64. *Location and Control of Institute.*—The Provincial Research Institute should be established at Lahore and should be in close touch with the Government College. At the present moment there are few industries, other than agriculture, of importance in the Province, although the field for development is a large one and the raw materials considerable. It is evident therefore that this Research Institute will have to devote its attention almost entirely to the establishment and development of new industries.

Training.—Suitable training can be imparted at the Government College, and greater facilities will be available when the proposed new buildings are erected and equipped. It is hoped that facilities for training in engineering will also be provided.

Burma.

65. *Location and Control of Institute.*—The Provincial Research Institute will be located in Rangoon. We understand that the Government of Burma is prepared to adopt the scheme and to appoint a Director of Research. They are also prepared to erect the Institute at an early date.

Training.—There is at present no adequate provision in Burma for the training of students in research methods or for an Honours' degree and it is suggested that promising students of the Government College should be sent to Calcutta for training. No doubt when the projected University has been created this defect will be remedied.

Central Provinces and Berar.

66. *Location and Control of Institute.*—The Provincial Institute should be at Nagpur and the Administration is, we understand, prepared to undertake the financing and control of the Institute.

Training.—At the present time there is no adequate provision for training recruits for the service in this Province. Facilities for training will, however, be available when the new College of Science is built and efficiently staffed.

Assam.

67. Assam was excluded from the President's programme and we are therefore unable to express a definite opinion as to the location of a Research Institute in the Province. Assam is however the seat of many industries, developed and developing, and it will be desirable to take an early opportunity for an industrial survey.

CHAPTER XII.

The Bureau of Information and Record Office.

68. The chief Bureau of Information and Record office would be established at the Central Imperial Institute and would be complete in so far as it would contain information concerning the progress of chemical science and industry throughout the world. It would also hold a record of all work done in India both at the Central Institute and the Provincial Institutes, as well as elsewhere. Each Provincial Institute would also contain a Bureau of Information and Record office, which would be kept up to date by the issue at intervals of abstracts and précis by the Central Institute.

Bureaus of Information.

If any information required by a manufacturer were not available at the Provincial Institute, application for information would be made to the Central Institute and, if it could not be supplied there, a request would be made by the Central Institute to the Department of Scientific and Industrial Research in England for any records they might be able to supply on the subject.

It is desirable that all applications from manufacturers and intending manufacturers should be made in the first instance to the Bureaus of Commercial and Industrial Intelligence which it is hoped will be constituted in the Provinces, because in this way applications of a chemical character would be separated from those which were not based on chemistry and would be transferred for disposal to the Director of Research. It is evident therefore that the Bureau of Information and Record

office will form an important feature both of the Central Research Institute and the Provincial Research Institutes and that a competent person must be appointed to the position of Record officer in each place. It is possible that the post of Librarian can, in the first instance, be combined with that of Record officer, provided that an assistant Librarian is appointed. There is no doubt, however, that as the service grows the two posts will have to be separated and that a Record officer with an efficient staff will have to be placed in charge of each Bureau.

The Library.

Library.

69. Both the Central Imperial Institute and the Provincial Research Institutes should be equipped with complete Libraries containing, so far as practicable, a complete series of the more important scientific and technological publications issued throughout the world. It would be the duty of the Librarian at the Central Institute to issue periodically a list of all scientific and technological publications relative to the work of the Service, and to circulate it to the various Provincial Research Institutes.

The Museum.

Museums.

70. There should be a Museum attached to each Provincial Institute and to the Central Institute, in which specimens of raw materials showing the stages of their manufacture into finished products would be kept. There would also be instructional models showing the lay-out and equipment of factories dealing with the various industries based on chemistry. Since the Museum at the Central Institute would be divided into sections each dealing with some particular branch of chemistry, each section could be conven-

iently placed in charge of a Deputy Director. As a general rule, although not necessarily so, a Museum attached to the Provincial Institute would deal with products dealt with in that Province, while the Museum at the Central Institute would be " all-India " in character.

Publications.

71. In addition to the periodical publication of selected abstracts and précis of scientific and technical literature, and the issue from time to time of Book-lists to which reference has already been made, it would be the duty of the Board of Control of the Central Institute to issue, when required a publication containing a record of the completed work, not only of the Central Institute but of all the Provincial Research Institutes. This publication should also contain such matters of general industrial interest as the Board of Control and the Provincial Directors of Research might think desirable to make public. The publication should be issued at as frequent intervals as possible and every 12 months a year book should be issued containing progress reports and recommendations for development written by each Deputy Director and by the Director of Research of each Province.

Publications.

Year Book.

New matter would be published in the periodical already mentioned, but it is not intended that publication in this way should preclude publication in the recognized scientific journals. Indeed, it would be the object of the Service to encourage such publication, not only in order that the chemists attached to the Service might have every chance of gaining scientific prestige similar to that available to the academic research worker, but also in order that the work of the Service might reach a wider public

than would be possible through the issue of its own publications. In order to achieve these objects, publication in the recognised scientific journals must be made under the name of the man or men who have actually carried out the work and not under the name of the Head of the Department alone.

At first sight it may seem that a system of this kind might lead to unnecessary duplication, but this danger will be obviated by the fact that the papers published by the Central Institute will be very full in character and written in such a way as would make them intelligible to the educated layman, whereas the scientific publications would be of the usual abbreviated kind required by publication committees and would be written for the information of the initiated only. No scientific publication would be issued from the Central Institute without the approval of the Director General or from a Provincial Institute without the consent of the Director of Research. Permission to publish should only be withheld when it is necessary in the interests of the State or, of a particular industry, that secrecy should be preserved.

Chemical Survey of India.

72. It has already been stated that in our opinion it is urgently necessary at the earliest possible moment to start a systematic chemico-botanical survey of the Indian Forests. It is no less urgent, in order to provide adequate data for the Bureau of Information, that steps should be taken in the immediate future to commence a chemical survey of non-forest lands. For example little or nothing is known of the vast salt deposits at Kharaghoda, and one of the first duties of the Director of Research

Chemical Survey.

appointed to the Bombay Presidency should be to erect a sub-station in this district and to subject the area to thorough investigation by a staff of skilled chemists in order to determine its industrial importance. India teems with examples such as this, but nothing can be done until the Director of Research in each Province has carried out a systematic survey of this nature. The survey should, as already recommended, be carried out in collaboration with other Departments in each Province, but the Director General should be kept in close touch with the progress of the survey, and copies of the results should be sent to the Central Imperial Institute for record. In order to carry out this survey effectively a considerable number of chemists would be required, a number probably too great for the normal establishment of the Provincial Institute to supply. It may therefore be necessary for the Central Institute to second chemists to the Provincial Institute especially for this purpose.

CHAPTER XIII.

Proposed Ministry of Science.

73. The Industrial Commission propose to attach the Chemical Service to the Industries Portfolio, to which the acceleration of the industrial development of India is to be entrusted. The foundation of the industries of the country is laid in agriculture, in forestry, in the mineral deposits, in the air, and in the water and other power that is available. In view of this and in view of the close co-ordination that must exist between forestry, agriculture, industry and chemical research, we consider it advisable that the following departments should, in the case of the Imperial Government, be attached to the same portfolio :

Industries
Chemical Research
Forests
Agriculture
Geology
Mines
Fisheries

and to these might be added

The Botanical Survey
The Meteorological Department and
The Zoological Survey.

In paragraphs 16 and 17 of Sir Llewellyn Smith's report it is pointed out that the projected Department

of Industries is still in incubation and that a temporary Board of Industries and Munitions is to be established during the transition period. We recommend therefore that, before the new Department takes final form, the allocation of subjects should be re-considered. In this way we believe that a step would be taken towards the establishment of that most desirable and necessary of all Ministries, a Ministry of Science.

Provincial Ministries of Science.

74. It is too early to look for Ministries of Science in the Provinces, where we are faced with the question of "reserved" and "transferred" subjects. We observe, however, from Appendix F of the Joint Committee's Report, that in Bombay Presidency the four scientific Departments of Agriculture, Industries, Fisheries and Forests have been "transferred" and that in the other provinces, with the exception of Assam, the first three of these subjects have also been "transferred." We have no hesitation in recommending that Chemical Research, which is closely allied to, and bound up with, the majority of these Departments, should also be made a "transferred" subject. We hope therefore that in time it may be possible to form Ministries of Science in the Provinces, as well as in the Central Government.

CHAPTER XIV.

Position of the Director General and of Directors of Research.

The Director General.

Relation of Director General to the Government of India.

75. The position of the heads of "attached" departments, such as the Chemical Service will be, has been dealt with by Sir Llewellyn Smith's Committee in paragraph 53 of its report. The Committee points out the difficulty under which an "attached" department labours when dealing with the Government of India Secretariat through the medium of outside references, and has stated that "the proposals of "the Attached Office come to the Secretariat as a receipt "from the outside, and the Secretariat naturally tends "to develop a clerical branch corresponding to each "Attached Office for the purpose of examining these "proposals from a general administrative point of view. "It is evident that unless the relations between the "Attached Office and the parent Department are very "carefully adjusted, and the criticisms of the Secre-"triat kept strictly within proper bounds, there are "great opportunities for duplication of work to the "grave prejudice of the prompt and efficient transaction "of business." In order to solve these difficulties, Sir Llewellyn Smith has proposed, in paragraph 78 of his Report, that heads of "attached" offices should in future note direct to the Secretary of the Department. His object is to prevent a proposal of an "attached" department being subjected to the minute and often unintelligent criticism of a hierarchy of subordinate noting

officers in the main department. Though we realise the presence of the disease and appreciate the correctness of the diagnosis, we do not consider that the suggested remedy will provide a cure ; for the tendency to treat references from " attached " offices as outside receipts, and to note upon them as of yore, will still remain.

Sir Llewellyn Smith has referred in paragraph 53 to the "advisory" departments (the Inspector General of Forests and the Director General, Indian Medical Service) and to the procedure by which they are governed. We have made enquiries and have ascertained that the Director General, Indian Medical Service, and the Inspector General of Forests have little or nothing in common. The former has an independent office and corresponds with the Government of India from outside. So far as administration is concerned he is subordinate to the Home Department, in the case of sanitary questions to the Education Department and with reference to Medical Stores to the Army Department. The Inspector General stands on a different footing and presents an analogy which we desire to follow. A brief description of his position is therefore given below.

The Inspector General of Forests performs two functions. In the first place, he is the head of the Forest Branch of the Government of India Secretariat (Revenue and Agriculture) and in this position he deals with all Government of India correspondence relating to Forest subjects. The papers when received in the main Secretariat are sent to the Assistant Inspector General from whom they proceed to the Inspector General. The latter forwards them direct to the Secretary to Government (Revenue and Agriculture), who submits them to the Member of Council. The Inspector General is also

empowered to send papers direct to other departments of the Secretariat, before submitting them to the Member through the Secretary. In the second place, the Inspector General controls the Forest Research Institute and College, Dehra Dun. In the exercise of control he holds the powers of a Local Government and in this capacity, as well as in some other branches of his work, he ought in theory to deal with the Government of India in the form of an outside reference. In the case of an officer so situated, this method of correspondence is both clumsy and unnecessary, and in practice the Inspector General adopts the procedure of the Secretariat note. We consider it essential to real efficiency, that an exactly similar relationship to that existing between the Inspector General and the main Government of India Secretariat, should be adopted in the case of the Director General of the Chemical Service : in which case both he and his office will be incorporated in the parent Department and his proposals will proceed direct to the Member through the Secretary to Government.

In paragraph 79 of the Report of Sir Llewellyn Smith's Committee it is recommended that "heads of "'attached' offices should be allowed to correspond on "technical matters direct with departments other than "that to which they are directly subordinate." The Committee in making this recommendation seems to have underestimated the necessity and the position, and we would insist that the Director General should be placed in the same category as the Inspector General of Forests with regard to his powers of correspondence. Sir William Meyer in his memorandum on the "Origin and Functions of the Indian Governments" has pointed out that the Inspector General of Forests "can also "correspond direct with Local Governments and Conservators on technical matters and with reference to his

"inspections." And in article 26 of the Forest Code it is prescribed that the Inspector General may correspond direct with the Chief Conservators and Conservators "on professional subjects" and with Local Governments "with reference to any professional matter." We recommend that the Director General of the Chemical Service should have the right to correspond with the heads of other Imperial Departments, with Local Governments, with Directors of Research and with Chemists seconded to other departments on strictly technical and professional subjects.

We have stated in paragraph 21 that the Director General will also be Director of the Central Research Institute. As Director of the Institute he will be assisted by the heads of the different departments of chemistry, who are to be designated Deputy Directors. And in his capacity as Director, he must, like the Inspector General of Forests and the Agricultural Adviser to the Government of India in the case of the Research Institutes at Dehra Dun and at Pusa, be granted the powers of a Local Government.

Deputy Director General.

76. His headquarters will be with the Government of India and, as a considerable portion of his time will be spent at the Central Institute and a certain amount of time be devoted to general touring, he will require the help of a Personal Assistant. The latter must be a senior officer of standing, selected on account of his administrative ability; for he will not only relieve the Director General of all routine work but will, during the absence of the latter, deal directly both with the Secretary to Government and with the Central Institute. The Personal Assistant will in these circumstances, act in the capacity of a deputy to the Director General. We therefore

propose that he should bear the designation of Deputy Director General.

77. We consider it desirable, as we have already stated in paragraph 23, that the Director General should be in a position to tour throughout India, in order to co-ordinate the work being carried on in the Provinces. To secure this object the assent of the Local Governments is necessary and we would suggest that Provincial Governments and Adminstrations should issue a general authorisation to the Director General to visit their Province. It would furthermore be advisable to extend the authorisation to the Deputy Directors, who are the heads of the different Departments of Chemistry at the Central Institute. The Director General will not himself be personally conversant with all branches of chemistry and will find it necessary to depute the Deputy Directors to the Provinces to deal with the subjects in which they are specialists. But, in any case, the authorisation would not be made use of without previous intimation to the Local Government or Administration concerned.

Relation of Director General to Provincial Governments.

Directors of Research.

78. In some of the evidence which has been placed before us, it has been assumed that the heads of the Provincial Research Institutes will be subordinate to the Directors of Industries.

Relation of a Director of Research to his Provincial Government.

It has further been stated that the functions of the two Departments of Industries and Research will be so closely interrelated that no clear division can be made. We have, however, after considering the report of the Industrial Commission, come to the conclusion that a

clear line of demarcation exists. A brief enumeration of the proposed functions of the Director of Industries will make this clear. They may be classified as follows :—

I. *Village Industries.*—One of the most important tasks assigned to the Director is the resuscitation of cottage industries, chief among which, and one of vital importance to the country, is handloom weaving.

II. *Technical Education.*—To the Director of Industries will be entrusted the duty of initiating and controlling technical education, through the medium of Trades Schools, Industrial Schools, Schools of Handicraft and of Arts, Technical Schools and Schools of Technology.

III. *Industrial Engineering.*—It is proposed that the Provincial Departments of Industries should in this respect be modelled on that of Madras, where an Engineering branch is already in being which embraces sections for the boring of wells, for irrigation by means of oil and gas engines, and for the erection and maintenance of up-country factories such as mills, gins and presses.

IV. *Home Office work.*—This includes responsibility for the working of the Factory, Boiler and Electricity Acts, and will probably include a labour branch dealing with industrial welfare and industrial unrest.

V. *Stores.*—The Industrial Commission suggest in paragraph 197 of their report that the purchase of stores in the Provinces should be made through agencies forming part of the Provincial Departments of Industries.

VI. *Pioneer Factories.*—With the first five main branches of work, the Department of Research will have nothing to do. It is in the case of the pioneer factory, however, that the two Departments will have to keep in close touch and to work in conjunction. But the line

of demarcation seems clear, for the Director of Research will pioneer only such factories as are based on research carried out in his Institute.

VII. *Intelligence.*—It is true that the Director of Industries is to be made responsible for the supply of commercial and industrial information, and that the Director of Research will also have an information bureau, but it is no more necessary to subordinate the latter to the former than to subordinate the Forest and Agricultural Departments, which also collect and distrib information with regard to their own particular subje to the Department of Industries.

Not only, therefore, is there a clear line of demar tion between the two departments, but it should obvious that it is out of the question for one Direc to direct another, especially when the latter officer different and distinct functions and is of the same ra and importance. At the present, it may be taken for granted, Provincial Departments of Agriculture, Industries and Forests work in co-ordination with, and not in subordination to, one another. And should further co-ordination be required, it can without difficulty be obtained by subordinating departments, the work of whi it is desired to correlate, to the same Minister or Mem of Council.

We have had under consideration the report of Llewellyn Smith's Committee and have recommen that the Director General's office should form part the Government of India Secretariat and that the p tion and procedure adopted in the case of the Inspector General of Forests afford the best method by which the work of an "attached" officer and "attached" department can be most successfully initiated and carried through. We recommend that, in the case of the Pro-

vinces, the Director of Research should, if possible, be placed in a similar position, and that, if it is found impossible to make his office a branch of the Secretariat, he should at least be placed on the footing recommended in paragraph 78 of the Report of the Secretariat Procedure Committee and should note to the Secretary direct.

This proposal may be held to place the Director of Research in a privileged position when compared with the heads of analogous departments, such as the Directors of Industries, Agriculture or Fisheries, but the correct remedy is not to place the Director of Research in a position which Sir Llewellyn Smith's Committee has condemned but to place all the heads of "attached" departments in a similar position. Not only has the Secretariat Committee, which was appointed to make recommendations on this and similar points, pointed out the disadvantages of the existing procedure and suggested a remedy, but the Industrial Commission in paragraph 312 of its report has put forward a similar drastic recommendation. We have moreover been impressed by the fact that the heads of the departments whom we consulted have, of their own initiative, broached this very question, and have declared that the present relation between "attached" departments and Government Secretariats has not only been inimical but in many cases crippling to the working of their department. It is impossible to mention names, but it is a striking fact that the more distinguished the officer consulted the more emphatic was he that the present Secretariat procedure acted as a dead hand on progress and development.

We further recommend that Directors of Research should be empowered to correspond direct with the Director General.

CHAPTER XV.

Recruitment to the Chemical Service.

79. The success of the Imperial and Provincial Research Institutes will depend on the ability of the chemists with which they are staffed. It is our intention that these laboratories should be staffed mainly by Indians and the question of the recruitment of suitable men is therefore of the greatest importance. We have laid down in paragraph 33 the general qualifications which will be required, and it is our object to detail here the procedure which we consider will be necessary if satisfactory appointments are to be made, since we are strongly of opinion that in the past the method of recruitment to the various scientific services has been unsatisfactory.

Recruits to the Chemical Service may be divided into the following four classes :—

(1) Chemists recruited to the Service from outside India,

(2) Chemists recruited in India to the Service,

(3) Assistant Chemists recruited direct from Indian Universities,

and (4) Specialists recruited temporarily for the development of particular industries.

Methods of recruitment.

80. There should be no differentiation in the method of appointment of Indians and Europeans, and the appointment of all members of the Imperial Service, whether Indian

or European and whether recruited in India or elsewhere, should be made by the Secretary of State on the nomination of the Government of India. With regard to the actual selection, we have had before us the Secretary of State's despatch, No. 169 of 27th November 1919, and we note that both the Secretary of State and the Government of India have accepted the principle of Selection Committees for recruitment to the Educational Service, whether Imperial or Provincial. We accept the principle and proceed to formulate our proposals accordingly.

Selection Committee.

81. In the case of officers recruited to the Chemical Service, the nominating authority will be the Government of India. The appointment of the Selection Committee will therefore rest with them. The Selection Committee must be composed of Chemists, who possess a knowledge of, and are in touch with, the Universities and Training Institutions both of India and Europe. The Committee must further possess a knowledge of Indian conditions and must be fully cognisant, so far as European recruits are concerned, of the type of man who is likely to prove suitable to Indian conditions and to the requirements of the Chemical Service.

We therefore recommend that the Selection Committee should be an Indian Committee and not a Committee sitting in Europe, and we believe that the body that would best fulfil our requirements would be the proposed Board of Control. The Board of Control will be composed of eminent Chemists, experts in different branches of Chemistry, and in frequent touch with Universities and Professors of Chemistry. So far as Indian candidates are concerned, they will be able to obtain from local Directors of Research, and from the University and College Professors, a review of the work and of the

conduct and character of the candidates in the College, at the University or in the Department. And they will be able to summon all candidates to a personal interview.

Indian Recruits.

82. Indian nominees to the Service should be recruited in India and not in Europe, but in the case of Indians who have received their training in Europe, and who apply to the Board of Control for nomination, their recommendations will come from Europe as well as from India.

European Recruits.

As regards the recruitment of European members of the Service, the President and Members of the Board of Control will be in constant touch, both when in India and when on leave, with the Universities and Scientific Societies of Great Britain. They will therefore be in a position to make recommendations to the Government of India with regard to European entrants to the Chemical Service.

83. All appointments to the Chemical Service should be subject to probationary service for a period of three years. The period of probation should be open to termination at one month's notice, given by either party. Probationers whose services had been thus terminated, would receive, in the case of an officer appointed in India, his return rail fare, and in the case of an officer recruited abroad, his passage to England or to the country of embarkation.

Assistant Chemists.

84. Assistant Chemists should be appointed by the Board of Control in the case of Departments attached to the Imperial Government, and by the Local Governments in the case of the Provinces. We recommend that the selection

for the latter appointments should be entrusted to a Provincial Selection Committee, of which the Director of Research should be Chairman. Assistant Chemists should be on probation for two years. If after this period they appear to be suitable for appointment to the Imperial Service, they should be sent on deputation to Europe, or elsewhere, for a further period of training. They will on their return to India be eligible for appointment as Members of the Service, when vacancies arise. We anticipate that eventually the majority of our recruits will enter the service through class (3), and we consider that, as a general rule and under existing conditions, it is inadvisable that a chemist should be appointed to the Imperial Service who has not had a course of training outside India. In the case of men of proved ability this rule should be relaxed.

Recruitment of Specialists.

85. The recruitment of specialists for temporary appointments stands on a different footing. They will be men of special qualifications, recruited on special terms, and will not be members of the Service. Their method of selection must therefore vary and we content ourselves with recommending that the nomination of a specialist be made by the Imperial Government, or by the Local Government requiring his services.

Posting of Chemists to Provinces and other Departments.

86. There is another matter that requires mention, when dealing with recruitment, and that is the posting of members of the Service to the Provinces and to other Departments. The appointment of Chemists to Provincial Research Institutes or to Provincial Departments will be made by the Local Government. Such appointments will doubtless be made on the recommendation of the Director of Research or of the

head of the Department, but in all cases, as the nominees are drawn from the Imperial Service, the appointment must be made in consultation with the Director General. Should the Director General consider that no available member of the service is suited to the post, or should the Local Government consider the nominee unsuitable, it will be open to the Local Government to request the Government of India to recruit a man for them from outside the ranks of the service, or to select their own man from outside the service. In the latter case the Local Government must submit their nomination to the Secretary of State through the Government of India, but without the concurrence of the Government of India a recruit so selected will not be a member of the Chemical Service. The Heads of Imperial Departments should be placed in a similar position with regard to chemists they desire to recruit to their department.

CHAPTER XVI.

Pay, Pensions, Leave and Allowances.

Pay and Pensions.

87. In 1912 a Royal Commission was appointed to investigate, among other cognate questions, the conditions of service, salary, leave and pensions of the Indian Services. They reported in August 1915, but it is only during the last year that the Secretary of State has dealt with the questions raised. We have before us his decision on the subject of pensions and on the scales of pay which he has laid down for the majority of Imperial Services. A general scale of pensions has been prescribed for all civil departments, with the exception of the Indian Civil Service, the pension of which service is fixed by statute and has been dealt with in a separate communication. But we understand that all the affected services are profoundly dissatisfied, and that the whole question must be reconsidered.

Comparisons of pay.

88. With regard to pay, we find that each service has been dealt with separately and that while certain general principles, such as time-scales, overseas allowances and, in the case of some departments, selection posts and efficiency bars, may be said to have emerged, we can find no definite common principle upon which these scales and

allowances have been based. To illustrate this remark, instances of these divergences are given below :—

INITIAL PAY—

Forests	Rs. 450.
Public Works . . .	Rs. 450.
Educational Service .	Rs. 400 *plus* O. S. A. of Rs. 150.
Geological Survey .	Rs. 400 *plus* O. S. A. of Rs. 150.
Indian Civil Service .	Rs. 450 *plus* O. S. A. of Rs. 150.
Police	Rs. 375 *plus* O. S. A. of Rs. 125.

TIME SCALE MAXIMA—

Forests	Rs. 1,600.
Public Works . . .	Rs. 1,600.
Educational Service .	Rs. 1,250 *plus* Rs. 250 O. S. A. *plus* 20 per cent. selection posts.
Police	Rs. 1,150 *plus* Rs. 250 O. S. A.
Geological Survey .	Rs. 1,200 *plus* Rs. 250 O. S. A.

PAY OF ADMINISTRATIVE POSTS—

Suptg. Engineers . .	Rs. 1,750—100—2,150.
Conservators . . .	Rs. 1,750—50—2,000.
D. I. G. Police . .	Rs. 1,600—100—2,000.
Supdts. Geological Survey.	Rs. 1,500—100—2,000.

PAY OF HIGHER ADMINISTRATIVE POSTS—

Chief Engineers . .	Rs. 2,750—125—3,000 *plus* Secretariat allowance.
Chief Conservators .	Rs. 2,500—125—2,750.
D. P. I., Major Provinces.	Rs. 2,500—100—3,000.
I. G. of Police, Major Provinces.	Rs. 2,500—100—3,000.

OVERSEAS ALLOWANCE—

Educational Service .	First 6 years . . .	Rs. 150.
	7th to 9th	Rs. 200.
	Thereafter	Rs. 250.

OVERSEAS ALLOWANCE—*contd.*

Geological Survey .	First 4 years . . .	Rs. 150.
	5th to 8th	Rs. 200.
	Thereafter	Rs. 250.
Indian Civil Service .	First 7 years . . .	Rs. 150.
	8th to 11th	Rs. 200.
	Thereafter	Rs. 250.
Indian Police . . .	First 6 years . . .	Rs. 125.
	7th to 10th	Rs. 150.
	11th to 13th	Rs. 200.
	Thereafter	Rs. 250.

EFFICIENCY BAR—

Indian Civil Service .	At the end of 12th year.
Public Works .	At the end of 8th year.
Indian Police . .	At the end of the 9th and 18th years.

We have not been able to find any underlying principle or reason on which these differentiations are based, which might guide us in framing our own suggestions and which we should be bound to follow. We understand moreover, that on account of these differences as well as for other reasons, the majority of the departments affected are dissatisfied and are pressing both for reconsideration and for the removal of a differentiation which has no clearly recognisable basis. We are, therefore, compelled, in formulating our proposals with regard to pay and pensions, to travel beyond the scales of pay and pension which have recently been promulgated and to endeavour to put forward a scheme based on definite reasons and clear-cut and intelligible principles.

Reasons for recommendations.

89. The main considerations on which we propose to ground our recommendations may be summarised. They are :—

(1) that the scales of pay and pension must be sufficient to attract the type of recruit required,

without being extravagant and without constituting an undue burden on the tax-payer,

(2) that the principle of an overseas allowance is essentially sound, both for Europeans who serve in India and for Indians deputed for service abroad,

(3) that, in the case of scientific services, the time scale must be based on age and not merely on length of service,

(4) that retirement must be based on age and not on length of service,

(5) that increments of pay must be greater in the earlier years of service than in the later years,

and (6) that a pension represents remuneration for services rendered, and that, while the minimum pension must be sufficient to enable an officer to live free from penury after retirement, officers who have been selected for administrative posts—and selection will be by merit and not by seniority—must receive a pension adequate to mark the value of their special work and services.

Scale of pay.

90. In accordance with these principles we put forward the following proposals as to scales of pay, pensions and conditions of retirement.

A. TIME SCALE—

Age.	Year.	Pay.	Overseas allowance.	Total.
		Rs.	Rs.	Rs.
25	1	400	150	550
26	2	500	150	650

A. TIME SCALE—*contd.*

Age.	Year.	Pay.	Overseas allowance.	Total.
		Rs.	Rs.	Rs.
27	3	600*	150	750
28	4	700	150	850
29	5	800	150	950
30	6	900	150	1,050
31	7	1,000	150	1,150
*Efficiency bar—				
32	8	1,040	200	1,240
33	9	1,080	200	1,280
34	10	1,120	200	1,320
35	11	1,160	200	1,360
36	12	1,200	200	1,400
37	13	1,240	250	1,490
38	14	1,280	250	1,530
39	15	1,320	250	1,570
40	16	1,360	250	1,610
41	17	1,400	250	1,650
42	18	1,440	250	1,690
43	19	1,480	250	1,730
44	20	1,500	250	1,750
45	21	1,500	250	1,750
46	22	1,500	250	1,750
47	23	1,500	250	1,750
48	24	1,500	250	1,750
49	25	1,500	250	1,750

* *N.B.*—The efficiency bar applies only to pay and not to the overseas allowance.*

B. PAY OF ADMINISTRATIVE POSTS—

(1) Superintendents of Ordnance Factories, The Chief Inspector of Explosives, and such other officers as may be held to be of equivalent rank.	Rs. 1,750—100—2,150.
(2) Directors of Research, Deputy Directors at the Central Institute.	Rs. 2,000—100—2,500.
(3) The Director General ..	Rs. 3,500.

The scale of pay, both as regards the initial rate and the maximum, has been fixed with the desire to attract to science a proportion of the brains and intellect which, in India, have in the past sought an outlet in the legal and literary professions. By providing an adequate career in science for University men of the front rank, we hope to attract the cream of the undergraduates of Indian Universities. With regard to European recruits, it is necessary that the Service should provide sufficient pay and prospects to enable the Universities of Great Britain, and the Institute of Chemistry, to recommend the Indian Chemical Service as a suitable career, even for the most talented of chemistry graduates.

Incremental system.

91. The incremental system possesses one novel feature. Promotion in the time scale is made by increments of one hundred rupees during the first seven years of service and by increments of forty rupees thereafter. The justification for this novel feature—and we hope that the views we hold will find general acceptance—lies in the fact that, in a Service recruited at the age of 25, a small increment is insufficient to meet the cost of living at a time when the majority of officers are married, or are contemplating matrimony, with consequent rapidly rising expenditure. And the expenditure rises more rapidly than can be met by a fifty rupee increment.

The remark applies to Indians and to Europeans alike. The Indian will, in all probability, be married before he joins the service and will have already incurred the responsibility and the increased expenditure involved in parenthood. Moreover the Indian who has joined as Assistant Chemist, and who has been selected for training in Europe before he joins the Service, will for two years be compelled, with the assistance it is true

of an overseas allowance, to reside abroad. And there will be a tendency for Indians, who have received a training in Europe, to adopt a scale of living which renders liberal remuneration, and a liberal increment during the "difficult" period, essential. The European will, in the majority of cases, have married by the age of 30; and matrimony, with its concomitant of a divided family, brings a heavy financial burden in its train. If, however, a European has attained a salary of Rs. 1,000 by the end of his 30th year, he will be freed from anxiety as to the making of ends meet and he will, with the help of his overseas allowance, be able to send his family to the hills, and when necessary to England, and to bear the expense of maintaining two establishments. An annual increment of fifty rupees, which is the generally accepted increment, will bring an officer to a stage at which he can afford to bear the burden of a family, and undertake the education of his children, only at the age of 40, by which time he would have attained the salary of eleven hundred rupees a month. An added advantage of the proposed system—and one that is of peculiar importance in the case of a scientific worker—is that he will be able to devote himself to research with a mind free from petty pecuniary worries.

These remarks may be held to apply to all services alike, but in the case of the Chemical Service an accelerated increment, in advance of the usually accepted standard of fifty rupees, is necessitated by the fact that we propose that members of the Service, who have not attained administrative rank, shall be compulsorily retired on attainment of their 50th birthday, that is, after a normal service of twenty-five years.

We have proposed a salary of Rs. 1,500 as an adequate maximum and we consider it reasonable that officers, who do not rise above the time scale, should receive

this salary for the last six years of their service. For this and for other reasons, we have refrained from adopting the principle of selection posts, which has been applied by the Secretary of State to the Department of Education. We have fixed the annual increments between Rs. 1,000 and Rs. 1,500 at forty rupees, since, after a standard of comfort has once been attained, the necessity for large increments has diminished.

Overseas allowance.

92. The need and justice of an overseas, or expatriation, allowance have long been recognised, and in the case of the Services, the pay of which has been most recently revised by the Secretary of State, this principle has been adopted. We have accepted the rates of Rs. 150, Rs. 200, and Rs. 250 as reasonable, and we have made the rate of Rs. 150 coincide with the period of rapid increment. The allowance has been raised thereafter to meet the increasing expenditure of an officer whose family is being educated in Europe. From the 32nd to the 36th years of age inclusive, we have added an allowance of Rs. 200 and thereafter we have proposed an allowance of Rs. 250 a month. These allowances we consider adequate, both for Europeans serving in India and for Indians who are deputed, during the period of their service, for study abroad.

Age of retirement.

93. We have fixed the age of retirement at 50, because we believe that an officer who has reached that age, and who has spent the effective part of his life in Government service in this country, has already passed the period of maximum efficiency. Moreover statistics have proved that officers who are compelled, as at present, to spend thirty years in the service of the State, or who retire at the existing superannuation age of 55, survive only for a few years to enjoy the leisure that they

have earned. In the case of two departments for which the figures have been worked out, we are informed that the average period, over which a pension has been drawn, has been less than five years. In the interests therefore of the State and of the individual alike, we consider that retirement should be enforced at the age of 50. We do not propose however that the principle underlying Article 459 (*b*) of the Civil Service Regulations* should be abrogated, nor do we consider that the rule should apply to the Director General, who ought, in our opinion, to hold the post for a minimum period of three years.

Age of recruitment.

94. We have selected the age of 25 as the starting point of our table, for we expect that recruits of the stamp and training required will have completed their 24th year by the time that they join the service. Should however an officer be recruited before he attains his 25th birthday, he will remain on the minimum pay until he completes his 25th year of age, when he will obtain his first increment. For the purposes of our time scale we have adopted the principle of an efficiency bar, and have based the limit, not so much on age or years of service, as on income. We consider that Rs. 1,000 a month represents the limit of income which should be paid to an officer who has been debarred from further promotion, and that no officer who has been proved inefficient should receive a higher rate of pay. We have, however, continued the overseas allowance even after the bar begins to operate, inasmuch as the causes, which have led to its institution, remain unaffected. We do not consider, however, that the imposition of an efficiency bar is the ideal or the correct method of disposing of the inefficient. It is to the best interest of the State, of the taxpayer, and of the Service that the failures should

*See Appendix III.

be removed. Two Royal Commissions which have sat in recent years, the Decentralisation Commission and the Public Services Commission, have alike recommended that the inefficient should not be retained in service, but should be weeded out. The Public Services Commission, in concluding their remarks with regard to the "compulsory retirement of inefficient officers" have stated that "we need only place on record our sense "of the importance to the service of a strict and regular "application of the principles to which the Secretary "of State has given his sanction." In view of the fact that the introduction of an efficiency bar by the Secretary of State in his more recent despatches has led us to believe that the recommendations of the two Royal Commissions referred to have been lost sight of, we desire, while retaining the efficiency bar, to call attention once more to the need for the strict enforcement of those recommendations.

At the same time as it may happen that officers are recruited to the Service when less than 25 years of age, it may be found that men whom it is desired to recruit are over that age. To meet such cases, we recommend that recruitment to the service should be permissible up to the age of 30. An entrant so appointed would receive the pay appropriate to his age and would be eligible for the Service pension. A chemist, recruited after he had passed his 30th birthday, would not join the Service, but would enter Government employ on a special agreement.

Pay of administrative posts.

95. In fixing the pay of the administrative posts, we have considered the salaries awarded to officers holding similar posts in other departments. Our recommendations are, however, based rather on the responsibility of the posts and the requirements of the

Service, than on a comparative estimate of the relative importance of the Chemical and other Services.

The post of Director of Research is one which requires administrative capacity and force of character in a marked degree, that of Superintendent of an Ordnance factory also carries heavy responsibilities. The pay of the Deputy Directors at the Central Institute has been so fixed as to attract men of high scientific attainments to the Service. The same scale has been adopted as for Directors of Research, for, while the latter represent a different type of officer with different qualifications, each, in his own line, is carrying out work of great importance to the country and deserves remuneration of equivalent value.

In addition to retirement at the superannuation age, we consider that it should be open to Government to retire an officer at an earlier age, and with this object we propose that Government should have the right to retire an officer at the age of 46, if they are satisfied that it is not essential in the interests of the public or of the Service that he should continue in employment. At the same time we recommend that members of the Service should have the option of retiring, with the permission of the Government under whom they are serving, at the age of 46. Retirement at the age of 46 would carry a reduced pension.

For the Director General we have proposed a fixed salary of Rs. 3,500 a month. In view of his position and in view of the fact that he will have three headquarters, Simla, Delhi and Dehra Dun, we believe that the salary proposed is moderate and reasonable.

Assistant Chemists.

96. Assistant Chemists will be officers of Provincial rank, although the post of Assistant Chemist will form the main avenue of recruitment to the Imperial Service. It

is only those Assistants, who are devoid of the necessary talent or ability, who will remain Assistant Chemists throughout their service. For these we recommend a salary of Rs. 150—25—200—20—500. Assistant Chemists should be compulsorily retired after completing twenty-five years' service, by which time they will have drawn their maximum pay for the last seven years of their service and should be eligible for a pension of Rs. 250 a month.

Pay of Special Officers.

97. There will be a number of officers, both of Imperial and Provincial rank, who will be attached to the Chemical Service although not members of it. Such officers are the Engineers who will be attached to the Institutes, the Librarians, the Record Officers, and the Curator of the Museum at the Central Institute. There will also be a number of foremen and engineering and allied subordinates. The pay of these officers must be determined after the need for their services has arisen.

Scale of pensions.

98. The scale of pensions for officers of the Civil Services has been prescribed in Resolution No. 1085-E.A. of the Finance Department of the Government of India. We have already pointed out that this scale has proved unacceptable to the concerned services, and we regret that we are unable to accept it as suitable to the Chemical Service. We, therefore, put forward our own proposals as to the minimum pensions which we consider acceptable.

We recommend a standard pension of Rs. 6,000 for officers who reach the age of superannuation, that is, on attainment of 50 years of age. For officers who retire, or are permitted to retire, at the age of 46, we recommend a pension of Rs. 5,000. When pensions are paid in

countries the currency of which is not on a rupee basis, the pension should be payable at the rate of exchange current, at the time of payment, between the British and Indian Governments, subject to the condition that 2*s.* is fixed as the minimum rate at which the rupee will be converted into sterling.

Officers, who have risen to administrative rank, should draw an extra pension of Rs. 300 a year for each year of service in such rank, and among them we include Directors of Research, Deputy Directors at the Central Institute, Superintendents of Ordnance Factories, the Deputy Director General and the Chief Inspector of Explosives. Special pensions of this nature should be subject to a maximum of Rs. 2,500, but should not be confined, as at present, to officers who have held the post for three completed years of effective service.

For the Director General we recommend a pension of Rs. 10,000 provided that he has held the post for a minimum of three years' effective service.

Experience has shown that, save in exceptional cases, it is not in the interest of the Service or of administration that an officer should hold the same administrative post for more than five years, excluding periods of leave or of absence from duty. We therefore recommend that an officer, who has held the same administrative post for five years of effective service and who is not transferred to another or higher administrative post, should, unless unquestionable public grounds for his retention exist, be compelled to retire, provided that he has reached the age of 46. In such a case he should receive the special pension for which officers who attain administrative rank are eligible.

99. In addition to pensions which have been earned at the retiring age, mention must be made of invalid pensions. We recommend that invalid pensions should be granted to officers who are compelled to retire on medical certificate after the completion of their 34th year. In their case we recommend an invalid pension of Rs. 2,000 a year and we recommend that for every further year of service a sum of Rs. 250 should be added so that, for instance, at the age of 45 an invalid pensioner would receive Rs. 4,500 a year. At the age of 46, he should be entitled to the reduced pension of Rs. 5,000, which we have already recommended. The addition of Rs. 250 a year thereafter would bring him at the age of 50 to the standard pension. No officer should however be entitled to a pension who has not served for ten years, a definite proportion of which, say nine-tenths, must consist of active service. In such cases a gratuity, and not a pension, should be awarded.

Invalid Pensions.

An officer, who has entered service when over the age of 25, shall not be entitled to an invalid pension until he has completed ten years' service.

100. It is obvious that our proposals with regard to pay and pensions can only be applicable to a duly constituted service. In the first instance it will be necessary both to recruit to the higher administrative posts, and to recruit senior chemists, direct. In their case, as in the case of specialists recruited for temporary employment, special agreements as to pay and pension must be made. We would, however, recommend that our rule, that no officer should hold the same administrative post for more than five years of actual service, should be enforced in all cases of special recruitment.

First recruitment to the Service.

Allowances.

101. We make the following recommendations with regard to allowances :—

Allowances.

(1) officers stationed in Burma, in Presidency towns, or in other stations in which special allowances are customarily granted, should be granted the customary special allowances,

(2) first class travelling allowance should be granted to all Imperial officers, as laid down in the Civil Service Regulations. To all Chemists a daily allowance of Rs. 5, and to administrative officers other than the Director General of Rs. 7-8-0, should be granted,

(3) the Director General should be entitled to a reserved compartment, when travelling by rail, and to one servant's fare in addition. He should also draw a daily allowance of Rs. 15, and, when halting in Bombay or Calcutta where hotel prices are high, of Rs. 25,

(4) road mileage should be granted at the rate of eight annas a mile,

(5) the Director General should, in view of the fact that his headquarters are with the Government of India, be granted a free house at Dehra Dun,

(6) the Deputy Director General should be entitled to a personal allowance of Rs. 300 a month in addition to his grade pay,

and (7) Assay Masters should, in view of the special responsibility attached to the post, receive a personal allowance of Rs. 200 a month.

Conditions of Leave.

Study leave compulsory.

102. We have no suggestions to offer with regard to the general leave rules, which have recently been revised, save to remark that all officers above the rank of Assistant Chemist should be subject to the European Service Leave Rules. With regard to the "study leave rules," however, we have certain proposals to put forward. The rules for study leave have been framed on the assumption that such leave is in the case of a large number of services desirable, but the fundamental difference between our proposals and the rules hitherto framed is that, while the latter are based on the assumption that study leave is permissive and permissible, we consider that in the case of the Chemical Service such leave should be made compulsory. It is essential for chemists to keep in touch with the scientific developments of other countries and to bring their knowledge up to date by frequently renewed contact with men of science and with the progress of research in other countries. We would, therefore, proceed further in this direction than the recent despatch of the Government of India, No. 363 of 1919, and would make liberal study leave an integral part of the conditions of service.

If study leave is to be made compulsory—and we would strongly deprecate any negation of a principle that we consider fundamental—the terms under which such leave is taken must be generous and attractive. It is on this understanding that the following proposals are framed :—

(1) every member of the Indian Chemical Service must have at least three periods of study leave during his first fifteen years of service,

(2) each period of study leave must be for a *minimum* period of six months,

(3) study leave should be on full pay and should count for promotion and pension, although it will not count as service for furlough or for other leave,

(4) a first class passage should be provided to and from India, and the actual travelling expenses of journeys undertaken for the purpose of study should be paid,

(5) fees paid to meet courses of study should be reimbursed,

(6) in the case of Indians who are sent abroad on study leave, an overseas allowance should be paid at the rate sanctioned for officers of their age. In the case of Europeans, no overseas allowance will be granted during the period of study leave spent in the United Kingdom, but subsistence allowances should be given if their studies are carried out on the Continent, in America, or in other foreign countries,

and (7) study leave should be combined with other forms of leave and the period spent on travel from and to India should count as privilege leave or furlough, and not as study leave.

Our first recommendation is based on the consideration that it is in the earlier years of his service, while his mind is elastic and his intellect pliable, that a scientific officer stationed in India should more frequently and at more regular intervals be kept in personal contact with European and American scientific advancement. While recommending, therefore, that three periods of study, of at least six months each, should be

made obligatory for all Imperial officers in the first fifteen years of their service, we would give it as our opinion that it would be preferable that every officer, save those who have been debarred from further promotion and who, we hope, will have left the service, should be granted six months' study leave at the end of every three years' service in India, until he has reached the age of 40.

In the Government of India despatch, which has already been referred to, a number of recommendations have been included for the revision of the existing rules. With two of these we are in cordial agreement, namely that study leave may be given in India as well as abroad and that Local Governments and Administrations should have the power of granting leave.

Deputation.

103. We are not concerned with the deputation of officers for the study of special problems either within or outside India, for such deputation is recognised as service and stands in a different category from leave granted for the purpose of study. We would venture to insist, however, that Article 85 of the Civil Service Regulations* should be so modified as to permit of deputation being made on the full salary drawn by an officer at the time that he is sent on deputation.

Privilege leave and furlough.

104. In view of the recommendation that we have made for the free grant of study leave, and in view of the fact that an officer who joins at the age of 25, and retires at the age of 50, will have earned his pension after twenty-five years' total service, we would further recommend that no officer should, in addition to his study leave, be entitled

*See Appendix III.

to more than three years' privilege leave and furlough during the course of his service.

Resignation.

105. In his despatch No. 50 Financial, of the 31st July 1919, the Secretary of State has agreed that, with the exception of probationers who have not yet been confirmed, future entrants into the services enumerated will not be entitled to resign their appointments without the previous sanction of the Government under which they are employed.

Conditions of resignation.

We have already suggested that officers of the Chemical Service should be seconded to private firms in order to develop industries, the experimental side of which they have worked out in a research institute. We would also permit them to resign, either to join the firm for which they have worked out the process, or to start independent work. But we would, as laid down by the Secretary of State, subject such resignation to the previous sanction of the Government under which an officer is serving, and would include the Indian Chemical Service in the revised list of services that are in future to be liable to this condition.

It is desirable, in the interests of India, that the special knowledge of industrial conditions and industrial processes acquired by members of the Service should be placed at the disposal of manufacturers. It is also desirable that members of the Service should be encouraged to pass from Government employment into commercial life, where their abilities may find further opportunity for improving and accelerating the industrial development of India. We, therefore, recommend that permission to resign and to enter private employment should be given freely and ungrudgingly.

CHAPTER XVII.

Finance.

Estimate of cost.

106. We fully realise that the acceptance of the proposals we have made in our Report must entail the expenditure of a considerable sum of money, but we consider that the expenditure of this sum should be regarded in the light of an investment which, if the development of the industries of India is at all commensurate with her great natural resources, must yield an ample return by placing the country in her proper position among industrial nations.

We have carefully considered whether we could give some estimate of the cost which is likely to be incurred by the establishment of a chemical service, and have reached the conclusion that nothing can be done in this connection until the Director General and the Directors of Research have been appointed. It will be one of the first duties of these officers to frame estimates both in regard to recurring expenditure for salaries and working expenses, and to non-recurring expenditure for buildings and equipment.

Special grants.

107. Once the Research Institutes have been erected and equipped, there will be no difficulty in following the usual financial procedure, but we consider it most desirable that in every annual budget provision should be made for a lump sum grant to be utilised for the general purposes of chemical research in relation to industrial development. Among these may be included

the establishment and equipment of pioneer chemical factories, the adaptation of potential new industries to the unit factory scale and the pay of special temporary officers required for specific purposes. These grants should not be subject to the usual accounts rules, but should be open to use by the Director General and by the Directors of Research when occasion demanded. It is only in this way that opportunity can be seized and the right moment utilised.

Grants of this kind are made at present in certain Provinces, but they cannot, we believe, be drawn upon without specific sanction for each item of expenditure. Procedure of this nature involves considerable delay, with consequent loss of efficiency and retardation of progress. We would therefore recommend that special grants for industrial experiments and pioneer factories should be spent at the discretion of the Head of the Institute, subject to the submission of vouchers and to periodical audit. If this suggestion be adopted, it should be possible to equip and run pioneer factories on business lines and on a commercial basis.

Special appointments.

108. We consider it necessary that wider powers should be granted in the matter of the appointments of special temporary officers. It will often happen that, if the services of the right man are to be secured, it will be necessary to make a decision at once and that there will be no time to follow the usual official procedure for obtaining sanction prior to his appointment. If has been brought to our notice, that in one case a factory manager, who had been appointed in anticipation of official sanction, had left his employment before the official sanction had been received, and it is clear that, if the Chemical Service is to achieve the objects for which

it is formed, some method must be devised by which occurrences of this kind can be obviated.

109. There is little doubt that the public announcement by Lord Crewe that the British Government were prepared to make a grant of one million pounds sterling for a period of five years in order to develop research in connection with the industries of the country, has had a marked effect on the attitude of British manufacturers towards research and has imbued them with confidence in the sincerity of the administration in its desire to assist. There is also little doubt that the announcement of grants for similar purposes by the Imperial and Provincial Governments of India would tend to engender a like confidence among manufacturers and intending manufacturers in this country.

CHAPTER XVIII.

Summary of Recommendations.

The following recommendations are made :—

(1) That a chemical service should be constituted.

(2) That the service should be called the Indian Chemical Service.

(3) That the Service should be controlled by a Director General.

(4) That a Central Imperial Chemical Research Institute should be erected at Dehra Dun under the Director General of the Chemical Service, as Director, assisted by a number of Deputy Directors.

(5) That each Deputy Director should be in charge of a separate Department and that, in the first instance, there should be four Departments, (*a*) Inorganic and Physical Chemistry (*b*) Organic Chemistry (*c*) Metallurgical Chemistry (*d*) Analytical Chemistry.

(6) That a Provincial Research Institute under the control of the Local Government should be erected in each Province near the chief seat of Industry in that Province, and that each Provincial Research Institute should be under a Director of Research.

(7) That the functions of the Central Imperial Institute should be as follows :—

(*i*) to create new industries and to carry out the development of new processes up to the "semi-large" scale, or further if necessary,

(*ii*) to investigate those problems of a fundamental character, arising from the work of the Provincial Institutes, which have been transferred to the Central Institute by the Local Director of Research in consultation with the Director General. Such problems will be those which have no apparent immediate practical importance, but which, in the opinion of the Director General and the Director of Research, are likely to lead to discoveries of fundamental industrial importance affecting the industries of the country generally,

(*iii*) assist in the co-ordination of the work in progress in the Provinces, both by means of personal discussion between the officers of the Central and Provincial Institutes during the course of the tours made by the Director General and the Deputy Directors, and by means of periodical conferences of Provincial and Imperial officers.

(*iv*) to carry out such analytical work as may be required and to correlate the methods of analysis in general use throughout the country,

(*v*) to maintain a Bureau of Information and Record Office,

and (*vi*) to issue such publications as are considered necessary.

(8) That the functions of the Provincial Research Institutes should be as follows :—

(*i*) to maintain close touch with the works chemists and with the works generally and to work

out any problems which may be submitted to them,

(*ii*) to develop and place on an industrial scale new industries which have been previously worked out on the laboratory and "semi-large" scale by the Central Imperial Institute,

(*iii*) to carry out such other work as may be necessary to establish and foster new industries peculiar to the Province,

(*iv*) to carry out such analytical work of a chemical character as may be required in the Province,

and (*v*) to erect and control sub-stations in such parts of the Province as the development of industry may require.

(9) That, under 8 (*i*) above, arrangements should be made by which a firm supplying a problem should have the use of the solution for an agreed period of time prior to its publication.

(10) That members of the Service should be lent to private firms as occasion demanded and should during the period of their service be paid an agreed sum by the firms.

(11) That the Research Institutes should not undertake manufacture in competition with private enterprise, but that chemical industries developed in accordance with 8 (*ii*) above should be handed over to private firms as soon as practicable.

(12) That, whenever necessary, experts should be employed to establish, chemical industries based on known processes. (Paragraph 85).

(13) That the work of the Central Imperial Institute should be controlled by a Board of which the Director General will be Chairman and which will comprise the Deputy Directors and such other persons as the Government of India may determine.

(14) That the Central Imperial Institute should have no administrative control over the Provincial Research Institutes, but that no appointment as Director of Research should be made without consulting the Director General.

(15) That the Director General and Deputy Directors should visit Provincial Research Institutes periodically and co-ordinate the work done in each.

(16) That chemists employed at Provincial Research Institutes should be appointed in the first instance by the Local Government in consultation with their Director of Research and the Director General.

(17) That chemists so appointed should be members of the Chemical Service and should be seconded for service under the Provincial Governments and be paid by them.

(18) That agricultural chemists should not at present be included in the service.

(19) That the relations of the Chemical Service to the Forest Department, the Ordnance Department, the Chief Inspector of Explosives, Assay Masters, the Medical Stores Department, the Geological Survey and other Government Departments employing chemists, should be as stated in chapters V and VII.

(20) That a Ministry of Science should be created as soon as practicable, (chapter XIII).

(21) That recruitment to the Chemical Service should be as described in chapter XV.

(22) That the Deputy Director in charge of Analytical Chemistry should co-ordinate the methods of analysis in use throughout India and should act in an advisory capacity to the various Provincial Government Analysts who should be attached to each Provincial Research Institute.

(23) That Provincial Government Analysts should be under the control of the Directors of Research and should take over the chemical work now carried out by the Chemical Examiner and the Government Test House.

(24) That the question of the connection of the Indian Institute of Science, Bangalore, with the Chemical Service should await proposals from the Council of the Institute.

(25) That the location and equipment of the Central Imperial Chemical Research Institute should be as described in chapter X.

(26) That the location, control and equipment of Provincial Research Institutes should be as described in chapter XI.

(27) That a Bureau of Information and Record office, a Library, and a Museum should be attached to the Central Imperial Institute and to each Provincial Research Institute.

(28) That the Central Imperial Institute should issue publications as described in paragraph 71.

(29) That a Chemical Survey of India should be carried out at the earliest possible moment.

(30) That recruits for the Chemical Service should be trained in the manner described in chapter VI.

(31) That Members of the Service should be seconded to the Education Department and to University Institutions if required, (chapter VI).

(32) That the Government of India should give maintenance and equipment grants to students, to enable them to undergo the training in chemical research required for recruitment.

(33) That the position of the Director General and of Directors of Research should be as described in chapter XIV.

(34) That the pay, pensions, leave and allowances of the Chemical Service should be as detailed in chapter XVI.

(35) That liberal grants, free from the customary accounts restrictions, should be given for the initiation of the scheme and for the development of industries through the medium of Chemical Research.

(Signed) JOCELYN THORPE,
President.
„ K. S. CALDWELL.
„ R. W. DAVIES.
„ W. H. HARRISON.
„ P. C. RAY.*
„ J. L. SIMONSEN.
„ J. J. SUDBOROUGH.

J. L. SIMONSEN,
Secretary.

*Subject to a separate note.

Note by Sir P. C. Ray, Kt., C.I.E., D.Sc., Ph.D., F.A.S.B.

On principle I am opposed *ab initio* to the creation of an all-India Chemical Service. At the earlier stages of the foundation of the British Empire, there was no doubt need for the creation of the Indian Civil Service and the Indian Medical Service, and, in the absence of suitable material in India, for their recruitment from abroad. Now after an interval of more than 160 years, under the enlightened auspices of the British Government, vast progress has been made in the intellectual development of India. We have graduates of the local Universities occupying conspicuous and distinguished positions as Advocate Generals, Judges, Jurists, Surgeons, Physicians and Scientists, etc., who can hold their own against their confreres in any country in Europe.

2. India is *par excellence* the land of caste, and the "services" have become stereotyped into so many rigid castes. Naturally they are jealous of their vested interests, and are apt to fight tooth and nail against any improvement or innovation which clashes therewith. So glaring has the evil become that, in the considered opinion of India, this unhappy country exists for the "services" and not the "services" for the country. In short, the "services" have become an anomaly, nay, a glaring anachronism. A man brought up under the inelastic and hide bound traditions of the "service" unconsciously imbibes all its prejudices and is apt to become overbearing, arrogant, narrow in outlook and limited in his angle of vision. The "service" system will have a demoralising effect as far as the spirit of research is concerned. The men will have gorgeous vistas of pay,

prospects and promotion before them, and the pushful and clamourous will try to gain the ear of the Heads of the "service." Under such a *regime*, I am afraid the spirit of research will not be properly fostered.

3. It has been urged that while big industries will have trained chemists to carry on researches, the results arrived at by the "service" chemists will be of benefit to the small industries. But the days of small industries are, I am afraid, numbered. In these days of fierce and keen world competition, and of powerful combines and trusts, industries started on a small capital will get short shrift.

4. The future industrial development of India no doubt requires a trained band of chemists. But I doubt very much if the proposed institution of an all-India Chemical Service will best meet the requirements of the case. "Service" men are apt to be easy going and secure of drawing their monthly cheque they cannot be expected to solve an industrial problem with that degree of zest and enthusiasm and personal interest which a research chemist, attached to an industry, is expected to bring to bear upon the question. Let me cite an instance based upon personal experience. During the exigencies of the recent war, the firm with which I have the honour to be intimately connected—I mean the Bengal Chemical and Pharmaceutical Works—was called upon to undertake, almost at a moment's notice, the manufacture on a large scale of many chemicals, the supply of which from abroad, had been cut off. Some of our chemists proved equal to the occasion in an incredibly short space of time. They not only worked out the processes but improvised plant for the manufacture, among other chemicals, of magnesium sulphate, alum, etc., by tons every day. One chemist worked out the process for

the manufacture of sodium thiosulphate, which extorted my admiration. Another, who also rose to the occasion, invented a fire extinguisher, which secured very large orders from the Munitions Department. Now, had the manufacture of any of these on a large scale been left to be worked out by departmental "service" chemists, I think that immense delay would have been involved, that the methods would have been found to be costly and unworkable, and that much precious time would have been lost in correspondence and cross-references. Departmentalism is an arsenal of delay and procrastination. Its methods are apt to run in a groove, and, as it has no living touch with any going concern, its ways degenerate into a dull dreary routine, mechanically carried out. A research chemist, who is in the "service" of industry, is put on his mettle. He naturally expects a share in the profits, or some sort of royalty, and he throws his whole heart into the work. Whereas a research chemist, who is in the "service" of Government, is part of a system, which not only makes havoc of originality, but has a tendency to chill initiative and resourcefulness. In short, work carried on through the agency of the "service," converts its votaries into lifeless machines. The methods of such a "service" will be dilatory and circumlocutory, especially if the laboratory happens to be situated at a great distance from the firm which wishes to avail itself of its services. In the proposed scheme, no doubt Pioneer Factories are suggested in connection with the laboratory. I believe the immense industrial progress, which has been achieved in England and in Germany, has been due mainly to the close association of chemists with the factories and the works. A large manufacturing concern can at once set up machinery and plant required for the purpose, and can change or improvise them according to the requirements of the

case. The phenomenal progress of chemical industry in Germany is due to the fact that the larger firms employ as many as 150 or 200 chemists, some engaged in research work, others in the actual manufacture. I doubt very much if the proposed all-India Chemical Service will be of benefit to the country, commensurate with the heavy outlay to be incurred.

5. My own view is that the best results would be achieved by improving the teaching of chemistry in the Indian Universities. The want of a suitable and lucrative career has hitherto stood in the way of capturing the brilliant students for the pursuit of chemistry. Law, Medicine and other careers have naturally attracted them. No doubt, the proposed chemical service, with the recruitment to its cadre in India, will give a fillip to the pursuit of chemistry. But the " service " cannot afford careers to all but only to a limited few. Unless we can open out in India chemical industries, metallurgical operations etc., there is no chance of absorption of a continuous flow of chemists.

6. India is a country of vast potential possibilities, with its abundant supply of raw materials, of animal, vegetable and mineral origin, and there is ample scope for research work on these. When the Industrial Commission made its recommendation for the creation of a Chemical Service, the Reforms Scheme was in a nebulous condition. Now that the bill has been passed and has taken a definite shape, with Provincial autonomy as its corner stone and Industry as a " transferred " subject, *the raison d'etre* for an all-India Chemical Service has almost ceased. Each Province grows on its own lines and according to its own traditions ; some Provinces are highly advanced intellectually and scientifically, others are again miserably backward and lag behind

in the race. If you start a chemical research institute in a backward Province, it will be something like putting the cart before the horse. Are people sufficiently advanced to profit by or to utilise it ? Under the Reforms Scheme, it will be possible for each Government, backed by the Local Parliament, to work out its own industrial salvation. That the local genius of the people plays a prominent part is best illustrated by the growth of the mill industry at Bombay. The Parsees and the Bhattias did not await to be awakened to activity by extraneous aid offered by Government Departments.

7. One important point is apt to be ignored. Chemical industries naturally advance *pari passu* with the scientific progress of the people. India is not like England where the people are practically on the same level of civilisation, advancement and progress. Bengal, Assam, Burma, Orissa and Chota Nagpur are not on the same intellectual level. Now, how will an all-India chemical service benefit each of these Provinces ? One deplorable result will be that the backward Provinces will not be able to utilise its services, but European and American exploiters will thrive at the expense of the people—a contingency which the Government of India itself deplores. In this connection I desire to quote the pronouncements of Sir Frederick Nicholson, of Sir William Clark, and of the present Viceroy. Sir Frederick Nicholson wrote as follows :—

> " I beg to record my opinion that in the
> " matter of Indian industries we are bound to
> " consider Indian interests firstly, secondly and
> " thirdly—I mean by 'firstly' that the local raw
> " products should be utilised, by 'secondly'
> " that industries should be introduced, and by

"'thirdly' that the profits of such industry "should remain in the country."

In the Viceroy's Council Sir William Clark announced that "the building of industries where the capital, control and management should be in the hands of Indians" is "the special object which we all have in view."

Finally Lord Chelmsford has stated :—

"We do not want mere Indian capital, we "want Indian men and not Indian men only "as labour but as leaders who will turn their "attention to industrial enterprise and equip "themselves for a great industrial regeneration "in India."

8. The plan which naturally commends itself to me is that the different Provincial Universities should be encouraged to strengthen the staff of chemical teachers and to attract brilliant young men by the offer of research scholarships. Technological Institutes should be attached to each University as an adjunct to the chemical and physical departments. In these, tanning, dyeing, ceramics, enamelling, electrical and mechanical engineering, paper making, etc., should be taught. If such Technological Institutes are attached to the Universities, much duplication of staff, of work, and of costly machinery will be obviated.

9. If you have to depend upon laboratory experiments for the forming of industries, I am afraid we shall have to postpone these to the Greek calends. I know, for instance, of a research laboratory in India where soap manufacture was undertaken on a laboratory scale. The product of this experiment has, however, been found to be of such inferior quality that it could not be

put on the market. Besides the Bengal Chemical and Pharmaceutical Works referred to above, I happen to be Chairman and Director of three or four other industrial companies that have recently been started, namely, the Bengal Pottery Works, the Bengal Soap Works and canning and condiment and other works. All these have been started with the help of experts trained locally or in Japan, England, Germany and America. The successful tannery works of Sir Nilratan Sirkar may also be mentioned in this connection. The late Jamshedji Tata also founded his colossal iron works with the help of technical experts imported from abroad. With the exception of the last named, the experts are all Indians trained abroad, as I have said, and a very large number of B. Scs., and M. Scs., are being trained under them, who will in course of time become experts themselves, while even in the Tata Iron and Steel Works, Indians trained abroad are slowly getting to occupy high posts in the various departments requiring scientific and metallurgical knowledge.

10. Suppose you want to start a condensed milk factory in a locality which commands the supply of cheap milk. According to the programme sketched in the Report, a band of chemists will undertake researches on the subject and make experiments, by means of plants set up on a miniature scale in the Demonstration and Pioneer factories attached to the laboratory. This will involve interminable delay, and moreover it may be found later on, though at a bitter cost, that the experiments performed on a small scale will prove to be commercially unworkable and non-paying. If a company were to be started for the manufacture of condensed milk, its management, instead of relying upon the precarious help offered by the Chemical Service, will secure an expert and a foreman and the necessary plant from, say, Switzer-

land and at once start the works. Under these experts Indians will be trained in the processes of manufacture, who will take the place of the imported specialists, as soon as the engagement of the latter has expired.

11. One objectionable feature of the proposed chemical service is that the Director of the Provincial Chemical Research Institute will naturally resent interference or control from the Director General as grandmotherly advice, although such control is euphemistically camouflaged under the terms "co-operation and advice." Another drawback is the multiplicity of highly paid posts *e. g.*, the Director General, the Deputy Director General, the Deputy Directors and the Provincial Directors of Research. Such a series of posts tends to formalism and is antagonistic to true research, which thrives best in the secluded atmosphere of the laboratory, untrammelled by vexatious interference from outside. I therefore doubt whether the suggested programme of tours is calculated to promote research, and I consider that the cost involved in the high expenditure that will be incurred in touring, will provide no adequate recompense.

12. With the progress in chemical education in India, qualified chemists will be turned out in numbers who will be readily absorbed by the chemical industries which are sure to spring up in course of time.

13. I am opposed to the creation of a chemical service corps. Recruits though selected from Honours' men are so many *dark horses*. During the last thirty years, I have been a teacher of chemistry and I have noticed that Honours' men, and even first class M. Scs., do not turn out always to be successful researchers. A researcher like a poet is, to a certain extent, born and not made. Very few men can catch the real inspiration from the teacher.

Thus I have often noticed that first class M. Scs., who have been offered research scholarships of Rs. 100 per month, have run away from the laboratory the moment they have got the offer of a " service " dangling before their eyes. The filling of the rank and file of the " service " by Honours' men properly apprenticed to Research Chemists does not augur well for the successful continuity of a race of research chemists. I have already said that the diffusion of teaching in pure and applied chemistry will be best secured by improving the staff of the University Professors and the importing of technological experts from abroad. For these posts the very *best* men should be appointed either permanently or for a term of five years (as first class men will not care to come out on permanent service) and, under them, meritorious and brilliant students should be trained as apprentices.

14. It is true that the Committee suggest that the inefficient should be weeded out ; but this will be found unworkable in actual practice. Once a man has been taken in, as in the Indian Civil Service, he must be provided with a job and promoted according to seniority. All that you can do is stop his promotion when he draws the pay of Rs. 1,000. The creation of a " service " means, in short, that we have to run the department with the help of good, bad and indifferent men.

15. I am distinctly of opinion that the chemical hierarchy, which it is proposed to create, will be a top heavy arrangement. It will be an expensive luxury. The crying need of the country is primary, secondary and even higher education. The Government of India has not got an inexhaustible Fortunatus' purse and, when it cannot spare money for these indispensible purposes,

it is scarcely justified in incurring such heavy fresh expenditure.

16. I need not proceed further. I hope I have sufficiently indicated that the installation of a chemical bureaucracy in all its glory is by no means a need devoutly to be wished for, in order to secure the industrial regeneration and salvation of India. The Report states at the outset "that a large proportion of the written "evidence is definitely in favour of the formation of a "Chemical Service." This is true, so far as it goes. Whether a matter of such importance should be decided by a mere show of hands, is quite another thing. I find at any rate that I am fortified, in the position I have taken, by the reasoned and most cogent arguments of the following gentlemen, each and all of whom are entitled to speak with authority:—

1. Dr. H. H. Mann, Director of Agriculture, Bombay.
2. Hon'ble Mr. J. G. Covernton, C.I.E., Director of Public Instruction, Bombay.
3. Rev. Dr. D. Mackichan, Principal Wilson College, Bombay.
4. Mr. F. Lewisohn, Revenue Secretary to the Government of Burma.
5. Rai Bahadur Ganga Ram, C.I.E., M.V.O., Lahore.
6. Lala Ruchi Ram Sahni, late Professor of Chemistry, Government College, Lahore.
7. Mr. S. M. Jacob, Director of Agriculture, Punjab.
8. Mr. B. H. Wilsdon, Agricultural Chemist to Government, Punjab.
9. Rai B. N. Das Bahadur, Professor, Dacca College
10. Mr. M. Balaji Rane, Professor of Chemistry, Benares Hindu University.

11. Mr. C. F. de la Fosse, Director of Public Instruction, United Provinces.

12. Mr. H. O. Kershaw, Professor of Chemistry, Presidency College, Madras.

17. In conclusion, I desire to state that, although I consider that the days of Government Services are over and that the development of industries by the agency of a Government Service is not the most suitable way of dealing with the problem, yet I agree that, if a Government Service is constituted, the proposals of the Committee represent the best method of constituting and carrying on such a service. It is for this reason that I have attached my signature to a report with the major portion of which I am in substantial agreement. The essence of the new scheme is the section on recruitment, which has been drawn up by the distinguished President himself and fully endorsed by my colleagues. The principle that recruitment for the Indian Services must be made in India is one which I have long upheld hitherto without success. I shall be satisfied if this principle finds acceptance as a result of the Committee's report, for it will afford a splendid opportunity to the youth and talent of India and will give a vigorous impetus to the pursuit of my favourite science amongst my countrymen.

(Signed) P. C. RAY.

APPENDIX I.

Evidence of Major G. H. Willis, C.I.E., M.V.O., M.I. Mech. E., R.E., Mint Master, Bombay.

My views on this question are coloured by my strong conviction that the Assay Department should cease to exist as a separate entity and that it would be a considerable economy and tend to better administration if the assayers formed part of the Mint staff, their technical reports being submitted unedited by the Mint Master to Government with his report. If this were accepted, it might be that a Chemical Service as proposed could supply assayers to the Mints as required, some of the junior chemists of the service being encouraged to qualify themselves for appointment to the Mint as vacancies occur. Some arrangement of this sort would be of great value, as with the present small establishments, leave or sickness vacancies, coinciding with heavy work in the Mints create great difficulty.

Since it is essential that assayers should be men of integrity and meticulously accurate workers, the terms of recruitment should be such as to ensure this. As regards control, they should, in my opinion, be under the Mint Master for all administrative purposes, but should be entitled to correspond direct with the head of the Chemical Service regarding technical matters and regarding their connection with that service. The head of the Chemical Service should be responsible that the Mints are kept supplied with the numbers of assayers

that the Mint Masters inform him are necessary up to the establishment sanctioned by Government. Ordinarily an assayer should find his whole career in the Mint when once he has joined that service permanently.

As far as the Mints are concerned a centrally located institute would be suitable. In busy times such a research institute might be of the greatest use to the Mints, since the assay work is often so heavy, that the Assay Master and his staff are unable to do the miscellaneous analytical work which the Mint Master requires for the efficient working of the Mint.

APPENDIX II.

Note on an intensive engineering course for chemists in the proposed Chemical Service by Mr. C. Graham Smith, A.C.G.I., A.M.I.C.E., Professor of Engineering, College of Engineering, Poona.

I was impressed with the arguments of the Committee that came to the College of Engineering the other day, in which they considered that the chemist could learn all that was necessary in a short course covering a period of, say, six months. I have discussed the question with a number of men, and none of them considered that a course of six months was sufficient, but on examination they came round to the conclusion that what was required could be done in the period already stated.

The time available might be divided more or less as follows:—

		15 per cent. carpentry.
		35 per cent. engineering shops, smithy, etc.
TOTAL	..	50 per cent. shops.
		20 per cent. sketching.
		30 per cent. mechanical and elementary drawing.
TOTAL	..	50 per cent. drawing.
GRAND TOTAL	..	100 per cent.

It should be noted that the sketching and drawing should be combined as much as possible, and these allocations cannot be adhered to rigidly. It is only put

forward as a guide. For example, a student might be required to measure up some engine detail, make a sketch of it, and from his sketch produce an engineering drawing.

A man with a natural aptitude for this kind of work might do all that is required in less than six months, but one with none would require longer.

Design should not be included in this course as it would or might lead to the chemist encroaching on the sphere of the engineer. Design could not be taught in the time, and the chemist does not require to be able to design.

It would be desirable, perhaps, to include a few lectures on materials of construction.

With six months devoted to drawing and shops it will be seen that the total number of hours spent on this work in six months approximates to the time spent by College of Engineering students in drawing and is more than they spend during the three years' course in the shops. Thus :—

6 months × 4 weeks × 6 days × 3 hours per day = to 432 hours.

In the workshop the sub-overseers get approximately :—

3 years × 9 months × 4 weeks × 6 hours per day = to 684 hours.

This is roughly as 2 : 3, and should be sufficient.

It should be remembered, however, that we would be dealing with a much better class of students, and one with a really trained mind.

APPENDIX III.

Extracts from the Civil Service Regulations referred to in paragraphs 37, 93 and 103 of the Report.

Article 89.—If an officer is transferred to duty which is such that he retains no connection with his own appointment and which there is reason to believe will not terminate within three years, the Local Government may, if it thinks fit, suspend his lien upon his own appointment altogether, and fill up that appointment substantively, reserving only the right to reverse the arrangements thus made in case the absent officer at any time reverts to his original appointment.

Article 459 (b).—Officers, other than ministerial, who have attained the age of 55 should ordinarily be required to retire, and should not be retained in service except where unquestionable public grounds for retention exist, and there is no doubt as to the physical fitness of the officer.

Article 85.—An officer of Government, whether paid from General Revenues, a Local Fund, or in Foreign service, who is deputed to, or detained in, Europe on special duty, is entitled to not more than two-thirds of the salary which he would draw were he on duty in India.

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